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AUTHOR Goodson-Roberts, Ludy; And Others
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ABSTRACT

This book of pretests and review exercises is designed to accompany the Engine Tune-Up Service Student Guide for Unit 1, Battery and Cranking System. Focus of the exercises and pretests is testing the battery and cranking system. Pretests and performance checklists are provided for each of the four performance objectives contained in the unit. There are 15 review exercises that are short check-ups to let the student know how well she/he has learned the material for one or more work activities covered in the Student Guide. Answers to all of the exercises are found at the back of the book. (YLB)

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ENGINE TUNE-UP SERVICE

Unit 1: Battery and Cranking System

Review Exercise Book

Automotive Mechanics Curriculum

ED218487

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Written by: Ludy Goodson-Roberts, Roger L. Richardson, E. Miles Bacon, and David Morse

THE AUTOMOTIVE MECHANICS CURRICULUM TEAM

Team Leader: Roger L. Richardson
Instructional Designer: Ludy Goodson-Roberts
Measurement and Evaluation Specialist: David Morse
Automotive Mechanics Curriculum Design Specialist: E. Miles Bacon
Subject Matter Specialist: Theodore R. May
Editor: Kathleen Lyons
Graphic Designer: John S. Matlock
Research Librarian: Marsha T. Paddock

CAREER EDUCATION CENTER, FLORIDA STATE UNIVERSITY

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Copy Staff: Betty Willard, Agnes Padgett
Illustrators: Julian Key, Abie Clements
Art Production Supervisor: Bob Burgun
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HOW TO USE THIS BOOK

In this Review Exercise Book you'll find pretests and review exercises. These tests and exercises cover the material in the Student Guide. The Student Guide will tell you when to do a review exercise, so don't start doing any of these exercises just yet.

PRETESTS

You will take the first pretest for Performance Objective 1 before you start working through the Student Guide. A pretest is a test designed to help you and your instructor find out what you already know. The questions on the pretest may also be used to help you review what you've learned after studying the material and doing the activities.

REVIEW EXERCISES

A review exercise is a short check-up that lets you know how well you've learned the material for one or more work activities covered in the Student Guide. It is a way of testing yourself. The back of this book contains the answers to all the exercises. You might be tempted to turn to the answers before you complete the questions, but if you do, you'll be the loser—for two reasons. In the first place, automotive mechanics is a skilled and dangerous trade. You need to know what you're doing and how to do it safely without having to check the book on every step. If you don't learn the material well, you can hurt yourself or damage the vehicle. In the second place, you'll eventually be graded by your instructor on how well you can do a performance objective. So if you look at the answers first, you'll just be wasting your time.

After you answer all the questions in a review exercise, check your answers with the ones in the back of the book. Review the material in the Student Guide for any question you had trouble with. Talk with your instructor if you're still unsure about any of the material covered in the Student Guide.

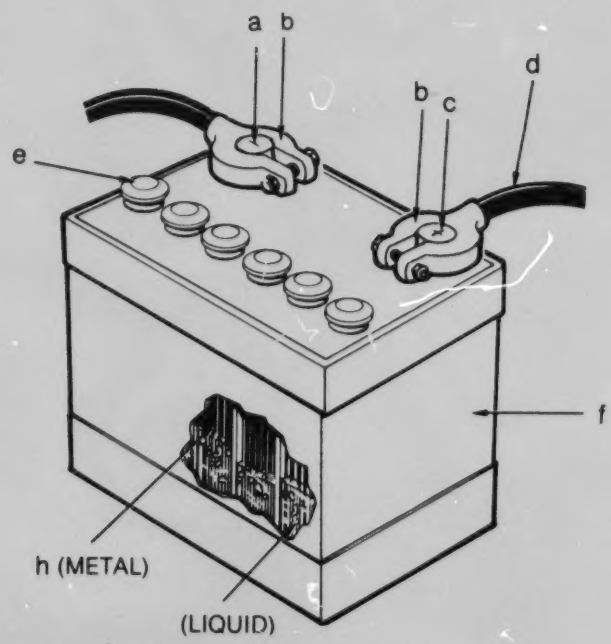
FINAL TESTS

There are only two tests on which you'll be graded. One of the tests will be a written test, and the other will be a performance test. If you've studied the material in the Student Guide, and if you've done the exercises and work activities as required, you'll have no trouble doing well on these final tests. You may even find them easy and fun to complete.

P.O. 1 PRETEST
PART 1

NAME _____

1. Identify each of the parts in the illustration by writing the number of the correct part name in the proper blank.

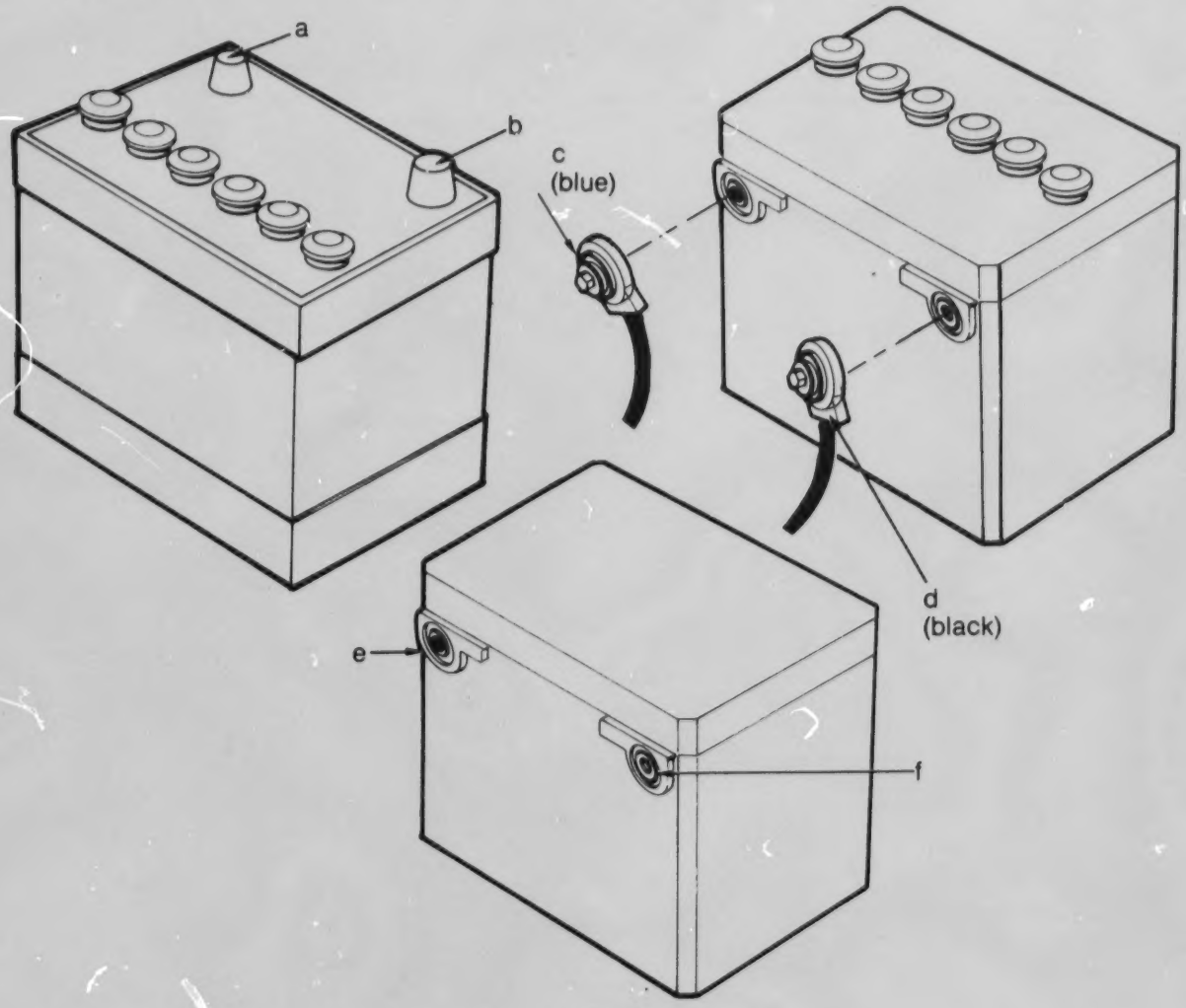


_____ a.
_____ b.
_____ c.
_____ d.
_____ e.
_____ f.
_____ g.
_____ h.

1. iron
2. cell
3. water
4. high voltage coil
5. sealing compound
6. electrolyte
7. battery cable clamp
8. negative terminal
9. casing
10. cable
11. vent caps
12. positive terminal

2. When a battery discharges, the amount of sulfuric acid in the battery electrolyte:
   _____ a. increases
   _____ b. decreases
   _____ c. remains the same

3. In the illustrations below, label each battery terminal to show whether it is positive (+) or negative (−).



4. Each cell in a lead-acid storage battery should produce about:

_____ a. 1.2 volts
_____ b. 2.2 volts
_____ c. 6 volts
_____ d. 13.2 volts

5. When the alternator or generator is working, the battery is:

_____ a. discharging
_____ b. charging

6. Place a check mark beside each of the actions you should take if you spill electrolyte on your arm.

_____ a. Pour water on it.
_____ b. Simply dry it on a towel.
_____ c. Pour floor cleaner on it.
_____ d. Get first-aid help.
_____ e. Pour vinegar on it.
_____ f. Put baking soda on it.

7. Place a check mark beside each of the actions you should take when you work with electrolyte.

_____ a. Wash your hands afterward.
_____ b. Wear rubber gloves.
_____ c. Work where plenty of water is nearby.
_____ d. Wear a protective apron.
_____ e. Avoid spilling electrolyte.
_____ f. Wear eye protection.

8. List one safety precaution to take for each of the following:

a. Jewelry _____

b. Clothing _____

c. Hair _____

9. Overfilling a battery is dangerous because:

_____ a. the battery voltage will decrease
_____ b. excess electrolyte will cause poor connections at cable clamps
_____ c. the battery will be overcharged
_____ d. excess electrolyte will eat away at paint and metal

10. Place a check mark beside each of the actions you should take if you splash electrolyte in your eye.

_____ a. Get first-aid help.
_____ b. Wash your eye with water.
_____ c. Simply dry your eye with a towel.
_____ d. Contact a doctor immediately.
_____ e. Put baking soda in your eye.

11. Battery electrolyte is at the proper level when it is:

_____ a. at the split ring in the cell
_____ b. above the split ring in the cell
_____ c. below the split ring in the cell

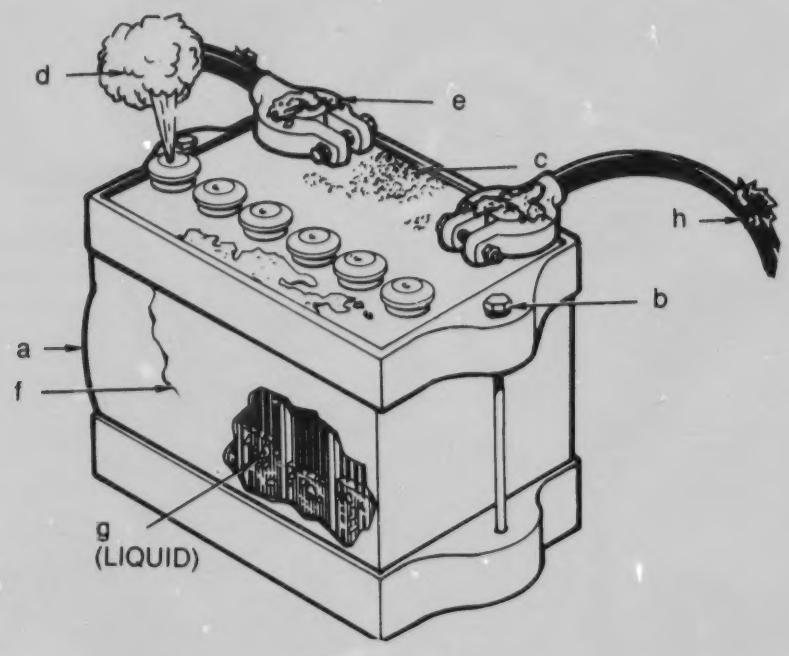
12. Place a check mark beside all of the safe ways to dry a battery.

_____ a. Allow it to air dry.
_____ b. Dry it with an air gun.
_____ c. Use shop towels to dry it.
_____ d. Use throw-away towels to dry it.

13. The proper fluid to add to a battery with a low electrolyte level is:

_____ a. tap water
_____ b. distilled water
_____ c. sulfuric acid
_____ d. any type of acid

14. Identify each of the defects in the illustration by writing the number of the defect in the proper blank.



_____ a.
_____ b.
_____ c.
_____ d.
_____ e.
_____ f.
_____ g.
_____ h.

1. frayed cable
2. corrosion
3. sealing compound
4. loose hold-down clamp
5. low electrolyte level
6. dirty battery case
7. overfilling
8. crack in battery case
9. bulge in battery case
10. sulfate crystals on battery

15. The battery in question 14 is most likely:

_____ a. undercharged
_____ b. overcharged

16. When you hook up battery cable clamps according to proper polarity, what terminal should you attach the ground cable to?

_____ a. negative
_____ b. positive
_____ c. insulated

17. The tool used to lift or move a battery is a:

_____ a. battery strap
_____ b. battery case
_____ c. hydraulic jack
_____ d. hand truck

18. Place a check mark beside all of the ratings listed below that you should check before selecting a new battery to replace an old one.

_____ a. volt-amp rating
_____ b. cold cranking capacity
_____ c. ampere-hour rating
_____ d. low voltage capacity
_____ e. reserve capacity rating

19. The steps listed below for removing a battery are out of order. Write the letter of each step in the blank beside the proper number to show the correct sequence.

Order

_____ 1. Inspect the casing for corrosion.
_____ 2. Remove the battery from the vehicle using a strap or carrier.
_____ 3. Use a fender cover to protect the vehicle.
_____ 4. Remove the insulated cable clamp.
_____ 5. Wear eye protection.
_____ 6. Remove the ground cable first.
_____ 7. Remove the hold-down brackets.

20. Which cable clamp should be removed first when you prepare to clean a battery?

_____ a. negative
_____ b. positive

21. When you are cleaning and drying a battery, the vent caps should be:

_____ a. removed from the battery
_____ b. left on the battery

22. The cable clamps are cleaned with:

_____ a. a wire brush
_____ b. shop rags

23. After cleaning a battery, you should rinse it with:

_____ a. water only
_____ b. baking soda and water

24. Which cable clamp should be installed first after the battery is cleaned?

_____ a. negative
_____ b. positive

25. Terminals and clamps should be protected after cleaning with (place a check mark beside all of the correct answers):

_____ a. baking soda and water
_____ b. anticorrosive paste
_____ c. oil
_____ d. acid-proof paint

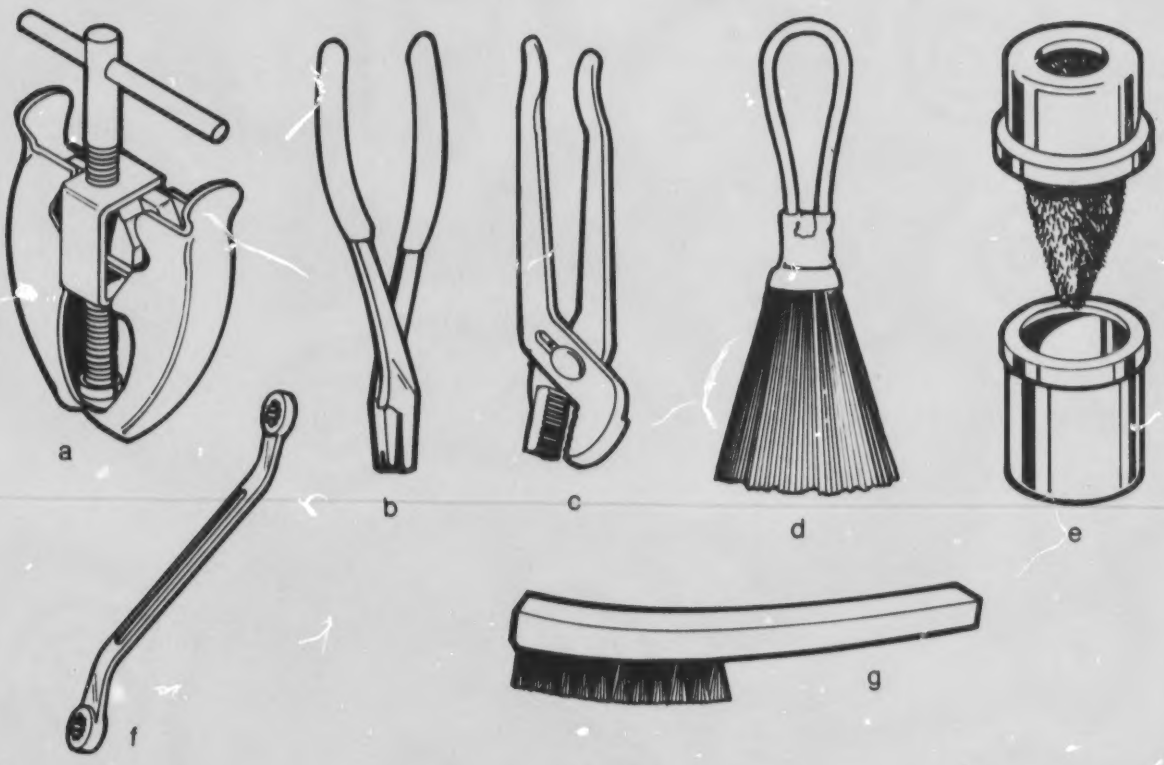
26. Place a check mark beside all of the safety practices you should follow when you clean and dry a battery.

_____ a. Let the battery air dry.
_____ b. Use throw-away rags to dry it.
_____ c. Leave the vent caps on.
_____ d. Remove the vent caps.
_____ e. Use an air gun to dry it.

27. Place a check mark beside all of the materials used to make a battery cleaner solution.

_____ a. electrolyte
_____ b. baking soda
_____ c. anticorrosive paste
_____ d. water
_____ e. milk

Answer questions 28-33 by writing the letter of the proper tool in the proper blank.



28. This tool is used to remove spring-type cable clamps. _____

29. These tools are used to clean cable clamps and terminals. _____ and _____

30. This tool is used to spread a nut-and-bolt clamp. _____

31. This tool is used to loosen the nut on a nut-and-bolt cable clamp. _____

32. This tool is used to pull a nut-and-bolt clamp. _____

33. These tools are used to clean the battery top. _____ and _____

34. A battery cable clamp that is very corroded or banged up should be:

    _____ a. removed, cleaned, and reinstalled
    _____ b. replaced

35. The last connection you make when you install a battery is:

    _____ a. the ground cable clamp
    _____ b. the insulated cable clamp

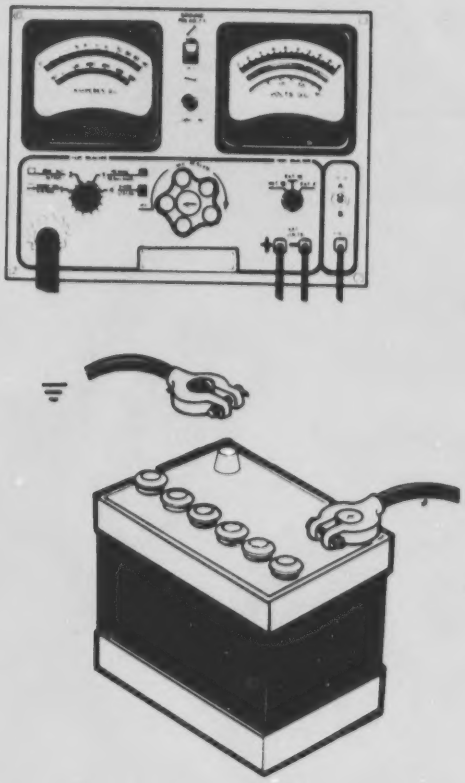
36. The best way to correct battery leakage is to:

    _____ a. clean the battery
    _____ b. paint the battery
    _____ c. replace the battery hold-down
    _____ d. replace cables and cable clamps

37. A reading of 0 volts in a battery leakage test means that:

    _____ a. no leakage exists
    _____ b. the cable clamp connections are poor
    _____ c. there is excessive resistance in the battery
    _____ d. the battery loses 12 volts and should be replaced

38. In the illustration below, draw the correct hookup for checking for battery leakage.



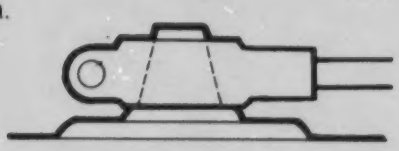
39. In most automotive vehicles, the insulated cable clamp is the same as the:

_____ a. positive (+) cable clamp
_____ b. negative (–) cable clamp

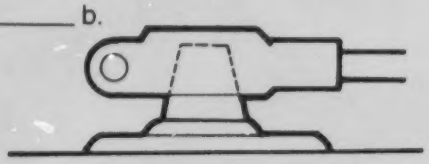
12

40. Which of the terminal clamps pictured in the illustrations below is (are) placed in the correct position? (Place a check mark beside all of the correct answers.)

_____ a.

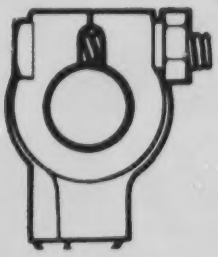


_____ b.

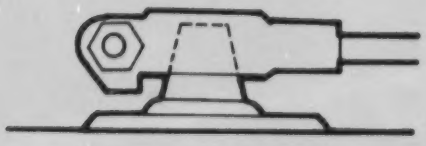


_____ c.

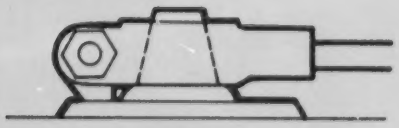
_____ d.



_____ e.



_____ f.



When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 1

1. In the illustration below, draw the electrical connections for the cranking system and name each part indicated by the letters.

a. _____

b. _____

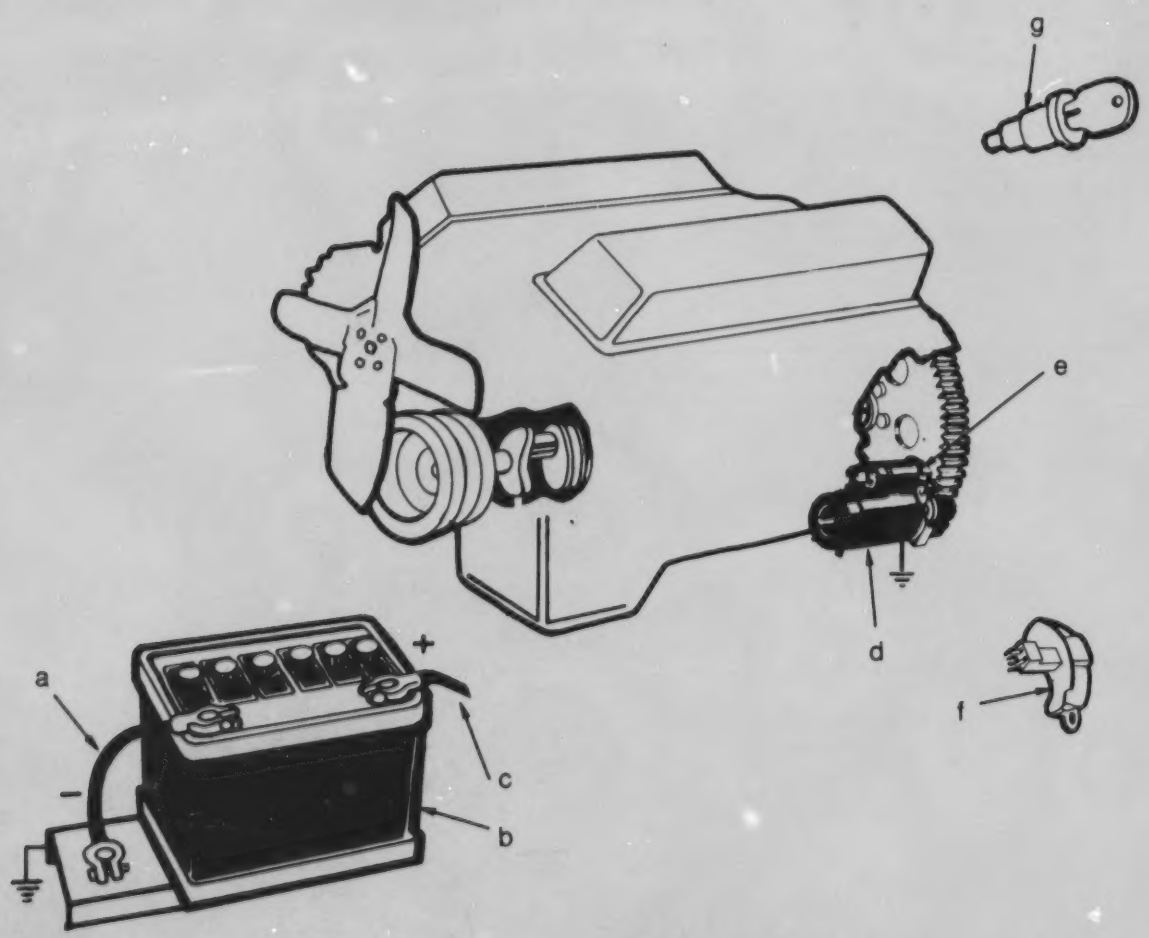
c. _____

d. _____

e. _____

f. _____

g. _____



2. What part is the source of voltage for the cranking system?_____

3. The cables that connect the battery to the cranking system are called _____ _____ . The cable that is attached to the cranking motor is called the _____ cable. The cable that is attached to the frame or engine of the vehicle is called the _____ cable.

4. What is the main part of the cranking system that causes the engine flywheel to turn?_____ _____

5. The switch that prevents the engine from cranking unless the transmission shifting lever is in the park position is called the _____ _____ switch.

6. What is the name of the gear that turns the flywheel when the engine is cranking? _____

7. The battery hydrometer is used to measure:
   _____ a. the size of the battery
   _____ b. battery electrolyte level
   _____ c. specific gravity (weight) of the electrolyte
   _____ d. battery state of charge

8. Is a voltmeter used to measure voltage of an electrical device as well as voltage between two points in a circuit?
   _____ a. yes
   _____ b. no

9. The voltmeter measurement is given in _____ .

10. Is an ammeter used to measure the amount of current in an electrical circuit?
    _____ a. yes
    _____ b. no

11. The ammeter measurement is given in _____ .

12. A device used to check the presence of electrical current in an electrical circuit is a _____ .

13. A unit of electrical current is an _____ .

14. A unit of electrical pressure is a _____ .

15. A circuit is:
    _____ a. a power source
    _____ b. an amperage
    _____ c. a battery cable
    _____ d. a path that electricity follows

15

16. Amperage is:

_____ a. the amount of electrical pressure in a circuit
_____ b. the amount of electrical current in a circuit
_____ c. the metal contact that completes the circuit
_____ d. the measurement of voltage

17. A load (electrical) is _____ in an electrical circuit.

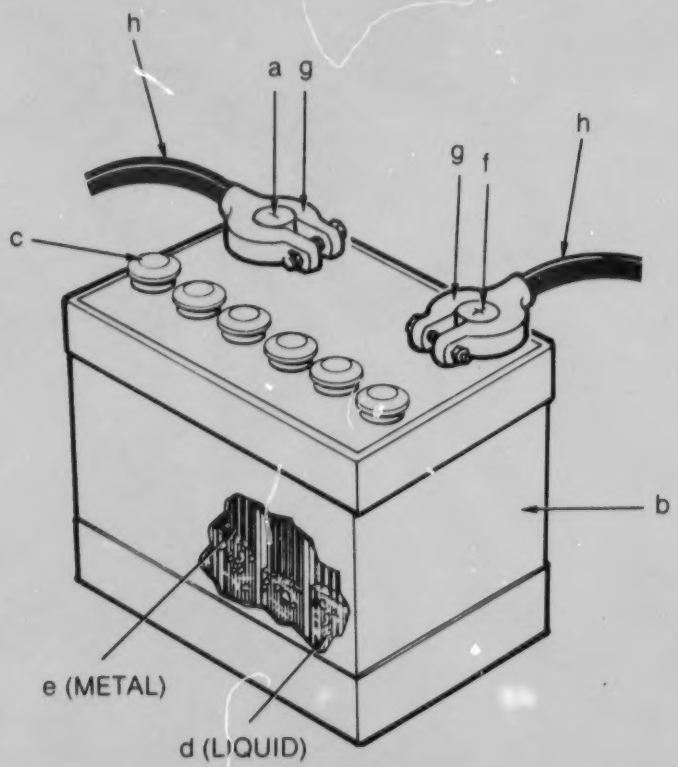
18. Voltage is:

_____ a. resistance in an electrical circuit
_____ b. the amount of electrical pressure in a circuit
_____ c. the amount of electrical current in a circuit
_____ d. the measurement of amperage

Now turn to the back of this book and check your answers for Exercise 1.

EXERCISE 2

1. Identify the parts marked in the illustration below.



a. _____ e. _____

b. _____ f. _____

c. _____ g. _____

d. _____ h. _____

2. In a negative ground system, the vehicle frame is connected to the battery by:

_____ a. the positive cable
_____ b. the negative cable
_____ c. both cables

3. In a negative ground system, the battery is connected to ground by:
   _____ a. the positive cable
   _____ b. the negative cable
   _____ c. both cables

4. The positive terminal post is:
   _____ a. larger than the negative terminal post
   _____ b. smaller than the negative terminal post
   _____ c. the same size as the negative terminal post

5. On a new battery that has the terminals on top, the terminal painted red is:
   _____ a. the positive terminal
   _____ b. the negative terminal
   _____ c. both terminals

6. On a side terminal battery, the terminal with the black cover is:
   _____ a. the positive terminal
   _____ b. the negative terminal
   _____ c. both terminals

7. If you're working on a 1972 vehicle, which ground system will it most likely have?
   _____ a. positive ground
   _____ b. negative ground
   _____ c. no ground

8. When the starter, radio, and air conditioner are running, the battery:
   _____ a. discharges
   _____ c. charges
   _____ c. electrolyte gets stronger

9. When the alternator or generator is working, the battery:
   _____ a. discharges
   _____ b. charges
   _____ c. electrolyte gets weaker

10. When the battery is discharging, the amount of sulfuric acid in the electrolyte:
    _____ a. increases
    _____ b. decreases

11. When the battery is discharging, the weight of the electrolyte:
    _____ a. increases
    _____ b. decreases

12. What two things make up battery electrolyte?

    a. _____

    b. _____

13. How many cells does a 12-volt battery have? _____

14. A loss of battery voltage is a loss of:

_____ a. power
_____ b. electrolyte
_____ c. water
_____ d. lead

15. How many volts are in one cell of a fully-charged battery? _____

16. Why is there a vent hole in the cap that covers the opening to a battery cell? _____

_____

17. The battery used in automotive vehicles is called a ***lead-acid storage battery*** because (complete all of the following sentences):

a. the battery cells have plates made of _____ .

b. the liquid inside the battery has _____ and _____ in it.

c. the reaction between the _____ and the _____ produces stored _____ .

18. What should you do if you get electrolyte on your skin?

_____

_____

19. What should you do if you get electrolyte in your eyes?

_____

_____

20. What should you wear to protect yourself when handling electrolyte?

a. _____

b. _____

c. _____

21. What should you do to your hands after completing any battery service?

_____

_____

22. When servicing the battery, place a _____ on the car fenders to protect the vehicle's finish.

For questions 23-28, tell why each of the practices is unsafe and should not be done.

23. Striking a match or causing any other spark or flame near a battery

_____

24. Wearing metal jewelry

_____

25. Wearing loose work clothes

_____

26. Letting long hair hang down when you're working around a battery

_____

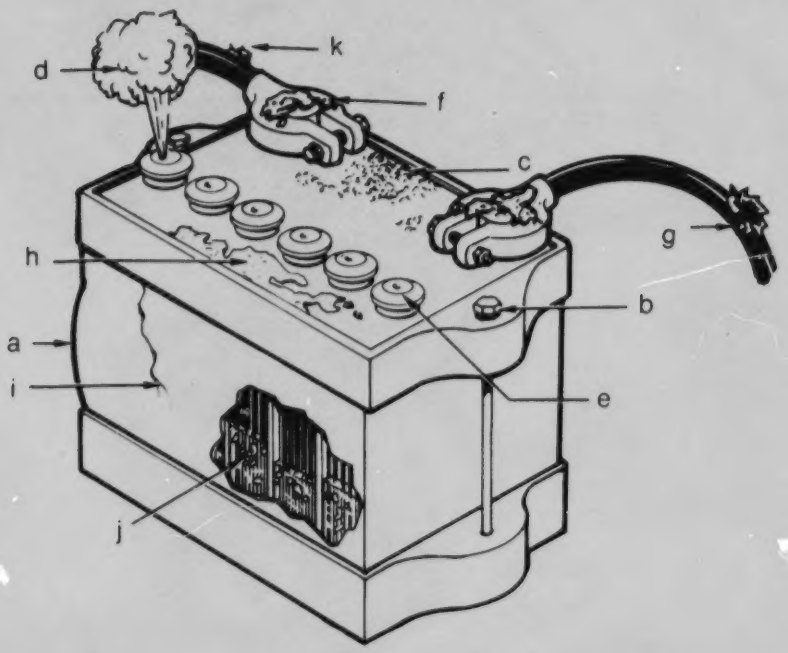
27. Not connecting the battery according to proper polarity

_____

28. Having loose battery connections

_____

29. Identify each of the parts in the illustration by writing the number of the correct part name in the proper blank.



_____ a.
_____ b.
_____ c.
_____ d.
_____ e.
_____ f.
_____ g.
_____ h.
_____ i.
_____ j.
_____ k.

1. frayed battery cable
2. corroded cable clamp
3. crack in battery case
4. overfilled battery cell
5. bulging battery case
6. corrosion (or dirt) on battery top
7. loose hold-down clamp
8. low electrolyte level
9. vent cap

30. List the probable correction for each of the following defects.

Defect	Correction
a. Low electrolyte level	_____
b. Overfilled battery cells	_____
c. Broken or worn cable	_____
d. Dirt or corrosion on the battery and connecting parts	_____
e. Crack in battery top or case	_____
f. Slight bulge in battery case	_____
g. Large bulge in battery case	_____
h. Loose hold-down clamps	_____

31. If there is a large bulge in the battery case and the top has heavy corrosion, what is the probable state of charge?

_____ a. overcharged
_____ b. undercharged

32. Why is a dirty and corroded battery undesirable?

_____

33. To check the electrolyte level, do the following steps (complete all three sentences):

a. Remove _____

b. Using a flashlight, _____.

c. Check to see whether the electrolyte level is even with the _____ _____.

34. If the electrolyte level is too low, do the following steps (complete all four sentences):

a. Use a _____ to add water to each cell.

b. Add water to each cell until the electrolyte level is even with the _____.

c. Reinstall each _____.

d. Be sure the _____ are open.

35. If the electrolyte level is low, do not add packaged _____ . Add _____ only.

36. What should you do if electrolyte spills out over the battery?

a. _____

b. _____

37. Why shouldn't you use an air hose to dry a battery?

_____

38. Why shouldn't you use shop rags to dry a battery?

_____

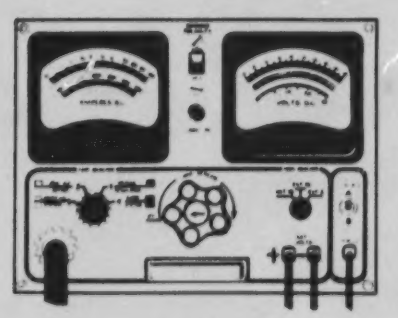
39. What's the best way to dry a battery?

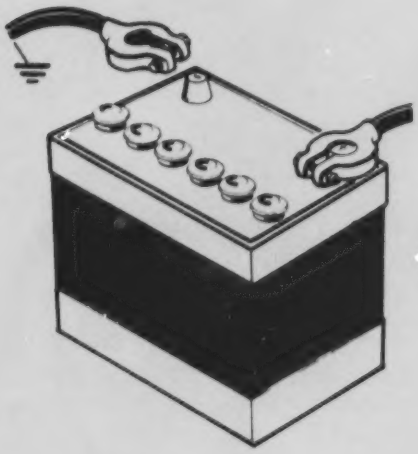
_____

Now turn to the back of this book and check your answers for Exercise 2.

EXERCISE 3

1. In the illustration below, draw the correct hookup arrangement for the battery leakage test when performed with a screwdriver.





2. When doing the battery leakage test, do not touch the _____ terminal post with the screwdriver or with the positive voltmeter prod.
3. When doing the battery leakage test, move the screwdriver or the positive voltmeter prod across the _____ .
4. List the action to take when you get the following readings on the battery leakage test:

Reading	Action
a. 0.0 volts	_____
b. 2.1 volts	_____

5. Which battery cable should you disconnect first? _____

6. To loosen the nuts and bolts and to spread the clamp on a nut-and-bolt-type battery clamp, you should use:

_____ a. the correct wrench and slip-joint pliers
_____ b. a box wrench and a screwdriver
_____ c. a clamp spreader and a hammer
_____ d. a screwdriver

7. To pull off a nut-and-bolt-type clamp, use:

_____ a. a box wrench and screwdriver
_____ b. a clamp spreader and box wrench
_____ c. battery pliers
_____ d. a clamp or jaw puller

8. To loosen, open, and lift off a spring-type clamp, you should use:

_____ a. a box wrench and clamp screwdriver
_____ b. a GM box wrench and screwdriver
_____ c. GM battery pliers
_____ d. a screwdriver

9. Which battery cable should you disconnect last?

_____ a. insulated
_____ b. ground

10. After both battery cables are disconnected:

_____ a. remove the vent caps
_____ b. remove the hold-down brackets
_____ c. remove the positive terminal
_____ d. replace the insulated cable

11. What tool should you use to lift and carry the battery?

_____

12. For each item below, list the safety practices to follow when cleaning and drying the battery.

a. Eyes _____

b. Sparks and flames _____

c. Ventilation and water _____

d. Tools and equipment _____

e. Vehicle fenders _____

f. Ground and insulated cables (1) _____

(2) _____

13. Before cleaning the clamps, terminals, or battery top:

_____ a. be sure the hold down clamps are tight
_____ b. be sure the vent caps are right and the vent holes are closed
_____ c. be sure the cables are on tight
_____ d. be sure the vent caps are tight and the vent holes are open

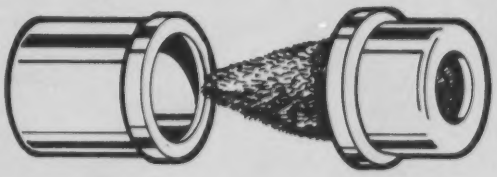
14. Match the parts to be cleaned with the proper tool. Write the number of the correct tool in the proper blank.

_____ a. cable clamps

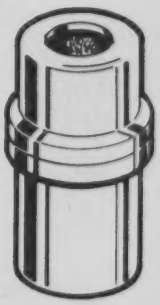
_____ b. terminal posts

_____ c. battery top

1.



2.



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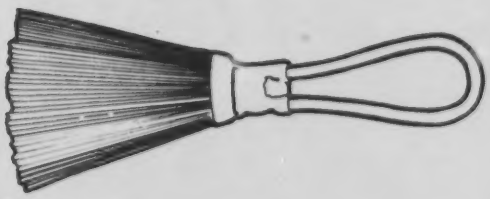


15. The cable clamps and terminal posts are clean when the metal looks _____.

16. Mix _____ of baking soda with _____ of water to make the baking soda solution for cleaning a battery.

17. The correct way to clean a battery with a baking soda solution is to (place a check mark beside all of the correct answers):

_____ a. keep the solution out of the vent holes
_____ b. rinse the battery and cable clamps with clean water
_____ c. clean the posts, cable clamps, and battery top
_____ d. rinse off the solution only after it stops foaming

18. The best way to dry a battery is to:

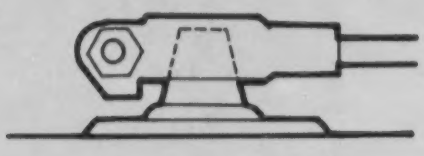
_____ a. dry it with an air hose
_____ b. let it dry naturally
_____ c. dry it with shop rags
_____ d. dry it with work clothes
_____ e. dry it with throw-away towels

19. After cleaning and drying the battery (place a check mark beside all of the correct answers):

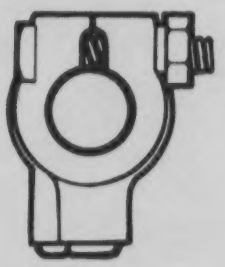
_____ a. remove the residue from other parts of the vehicle
_____ b. put the battery back in the vehicle
_____ c. connect the insulated cables first
_____ d. connect the ground cable last
_____ e. tighten the hold-down clamps

20. Place a check mark beside the correct connections for the battery clamps.

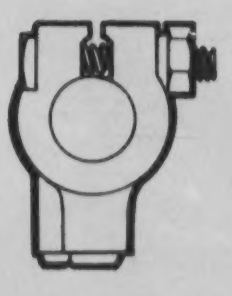
_____ a.



_____ c.



_____ b.



_____ d.

21. What cable should you reconnect first before you repeat the battery leakage test?

_____

22. If there is still battery leakage after the battery is thoroughly cleaned, the battery is probably

_____ .

23. When installing a new battery, be sure it has the same _____ and

_____ as the old one.

24. You have the following information on the 12-volt battery you've been testing:

BATTERY PERFORMANCE CHARACTERISTICS		
Cold Cranking 420 amps	Reserve Capacity 125 minutes	Ampere-Hour Capacity 80

You also know the wiring is good, all electrical equipment is turned off, the battery is clean, and the leakage test showed a reading of 4.0 volts.

a. Does the battery need to be replaced? _____

b. Why? _____

c. If you replace this battery with a new one, the new battery should have an ampere-hour rating of _____ .

d. The new battery should also be a _____-volt battery.

25. To finish installing a battery (place a check mark beside all of the correct answers):

_____ a. reconnect the alternator leads and the ground cable
_____ b. loosen the hold-down clamps
_____ c. paint the positive battery clamp and terminal with acid-proof paint
_____ d. paint the negative battery clamp and terminal with acid-proof paint

26. What could you use instead of acid-proof paint?

_____

27. When replacing battery cables or clamps (place a check mark beside all of the correct answers):

_____ a. select the correct cable size
_____ b. select the correct clamp size and length
_____ c. select the correct rating

Now turn to the back of this book and check your answers for Exercise 3.

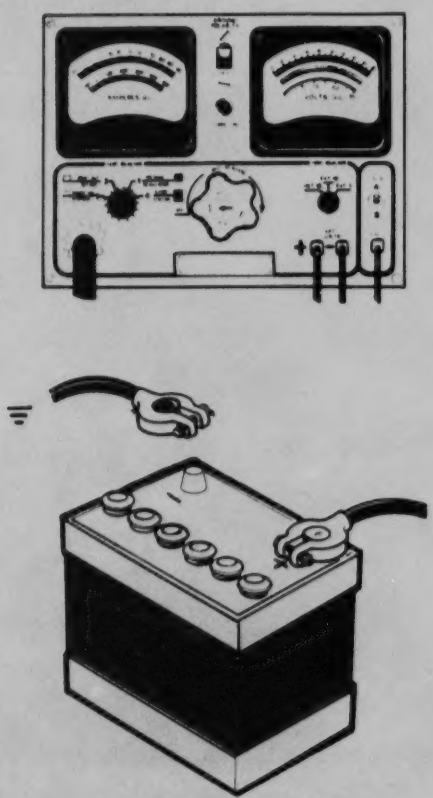
P.O. 1 PRETEST
PART 2

NAME _____

1. Which of the following is ***not*** a safe way to perform a battery drain test?
   - _____ a. Use a volt-amp tester.
   - _____ b. Use a voltmeter to detect drain.
   - _____ c. Touch the ground cable clamp to the terminal.
   - _____ d. Use a starting-charging systems circuit tester.

2. A battery drain test results in a reading of 13 volts. The most likely cause is:
   - _____ a. a weak battery
   - _____ b. current drain in the system
   - _____ c. a shorted or grounded circuit
   - _____ d. poorly connected battery clamps

3. In the illustration, draw the correct hookup for the battery drain test.



4. The equipment needed to measure battery specific gravity is:

   _____ a. a voltmeter
   _____ b. an ammeter
   _____ c. a hydrometer
   _____ d. a volt-amp tester

5. If you obtain specific gravity readings of 1.220, 1.270, 1.260, 1.270, 1.260, and 1.260, this means that the battery:

   _____ a. needs to be charged
   _____ b. should be replaced
   _____ c. is fully charged

6. If you obtain specific gravity readings of 1.280, 1.280, 1.280, 1.270, 1.280, and 1.280, this means that the battery:

   _____ a. needs to be charged
   _____ b. should be replaced
   _____ c. is fully charged

7. How much difference must there be in the specific gravity readings for cells before you can be sure that the battery is defective?

   _____ a. 10 points (.010)
   _____ b. 30 points (.030)
   _____ c. 50 points (.050)
   _____ d. 100 points (.100)

8. What is the true adjusted reading for a battery with a specific gravity of 1.230 at 70° F.?

   _____ a. 1.222
   _____ b. 1.226
   _____ c. 1.230
   _____ d. 1.234
   _____ e. 1.238

9. What is the true adjusted reading for a battery with a specific gravity reading of 1.240 at 95° F.?

   _____ a. 1.236
   _____ b. 1.240
   _____ c. 1.244
   _____ d. 1.248
   _____ e. 1.250

10. Place a check mark beside all of the things you should do before you charge a battery.

    _____ a. Clean corrosion from the terminals.
    _____ b. Remove the battery from the car.
    _____ c. Fill the cells with water to the level mark.
    _____ d. Remove and store the vent caps in a safe place.
    _____ e. Add electrolyte as needed.

11. The correct slow-charging rate for a 70-ampere-hour battery is approximately:
    _____ a. 3 amps
    _____ b. 3.5 amps
    _____ c. 5 amps
    _____ d. 7 amps
    _____ e. 10 amps

12. At what electrolyte temperature should the charging rate be decreased or stopped?
    _____ a. 100° F.
    _____ b. 125° F.
    _____ c. 200° F.
    _____ d. 225° F.

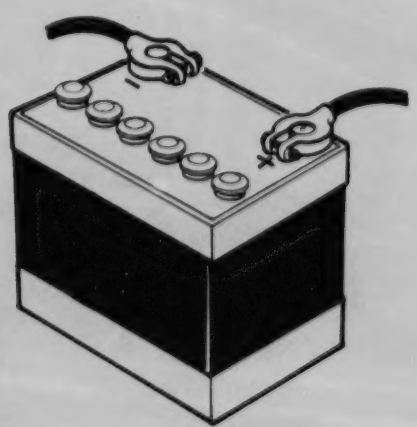
13. The battery has a temperature of 30° F. Is it safe to charge?
    _____ a. yes
    _____ b. no

14. The battery has a cracked case. Is it safe to charge?
    _____ a. yes
    _____ b. no

15. The battery is out of the vehicle. Is it safe to charge?
    _____ a. yes
    _____ b. no

16. In the illustration below, draw the correct hookup arrangement for charging a battery.

CHARGING

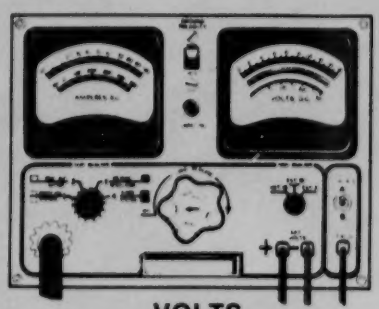


17. During a slow charge, a battery will not accept more charge when the specific gravity has stabilized for:

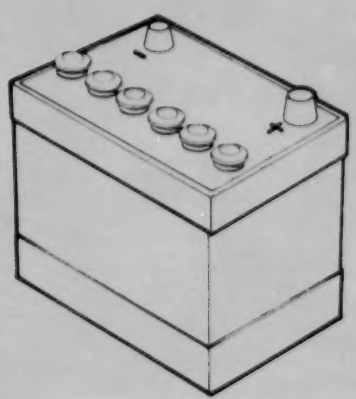
_____ a. 10 minutes
_____ b. 30 minutes
_____ c. 1 hour
_____ d. 2 hours
_____ e. 3 hours

18. In the illustration below, draw the correct hookup arrangement for a 3-minute charge test.

CHARGING



VOLTS



19. The battery has low voltage after 3 minutes. Is it safe to make a 3-minute charge test?

20. The battery has not yet been charged. Is it safe to make a 3-minute charge test?

_____ a. yes
_____ b. no

21. The battery sprays electrolyte during the 3-minute test. Is it safe to continue the test?

_____ a. yes
_____ b. no

22. The highest safe continuous charging rate for a 12-volt battery is:

_____ a. 15 amps
_____ b. 20 amps
_____ c. 30 amps
_____ d. 35 amps
_____ e. 40 amps

23. The voltage is 10.9 volts after the 3-minute charge test.

_____ a. The battery is okay.
_____ b. The battery should be replaced.
_____ c. The 3-minute charge test should be stopped.

24. The voltage is 16 volts after the 3-minute charge test.

_____ a. The battery is okay.
_____ b. The battery should be replaced.
_____ c. The 3-minute charge test should be stopped.

25. If you wanted to make a 3-minute charge test, but did not know how, you could find the procedure in:

_____ a. the battery manufacturer's literature
_____ b. the tester manufacturer's instructional manual
_____ c. the vehicle manufacturer's shop manual
_____ d. a technical service manual, such as ***Mitchell's***

26. Place a check mark beside all of the conditions that would ***prevent*** you from safely fast charging a battery.

_____ a. The battery is frozen.
_____ b. The charging area is well ventilated.
_____ c. The specific gravity of the cell is about 1.220.
_____ d. The battery has clogged vent caps.
_____ e. The battery is at room temperature.
_____ f. The battery fails the 3-minute charge test.

Use this table to help you answer question 27.

FAST CHARGING TABLE

Specific Gravity	Length of Fast Charge
1.225	Do not fast charge
1.200-1.225	0-15 minutes
1.175-1.200	15-30 minutes
1.150-1.175	30-45 minutes
1.150 or less	45 minutes -1 hour

27. How long should you fast charge these batteries?

Battery A: 1.180, 1.190, 1.180, 1.180, 1.180, 1.190 _____

Battery B: 1.230, 1.230, 1.240, 1.230, 1.230, 1.230 _____

Battery C: 1.210, 1.220, 1.210, 1.210, 1.220, 1.220 _____

28. When fast charging a sealed battery, the method for determining when to stop the charge is to measure:

_____ a. the electrolyte temperature
_____ b. the battery case temperature
_____ c. the battery voltage
_____ d. the battery amperage

29. A high discharge or battery capacity test measures:

_____ a. engine displacement
_____ b. battery load
_____ c. individual cell voltages
_____ d. total battery voltage

For questions 30 and 31, assume that the battery capacity load was determined from the ampere-hour rating or the load-test amp rating.

30. The battery voltage stabilized at 9.9 volts. The battery is:

_____ a. good
_____ b. marginal
_____ c. bad

31. The battery voltage stabilized at 9.3 volts. The battery is:

_____ a. good
_____ b. marginal
_____ c. bad

Use this table to help you answer questions 32-34.

ENGINE DISPLACEMENT	LOAD
Over 300 CID	235 amps
Under 300 CID	200 amps
Most 4 and 6 cylinder	170 amps

WORK SPACE

32. You're working on a 1976 Montego. The battery ampere-hour rating is 80 amperes. What load should you apply to test the battery capacity?

_____

33. You're working on a 1971 Duster. The engine displacement is 340 cubic inches. What load should you apply to test the battery?

_____

34. You're working on a 1974 Cutlass. The load-test amp is 180. What load should you apply to test the battery?

_____

35. During a battery capacity test, the load should be applied for:

_____ a. 15 seconds
_____ b. 30 seconds
_____ c. 1 minute
_____ d. 2 minutes
_____ e. 3 minutes

For questions 36-38, assume that the battery capacity load was determined from the engine displacement.

36. The battery voltage stabilized at 10.0 volts. The battery is:

_____ a. good
_____ b. marginal
_____ c. bad

37. The battery voltage stabilized at 9.2 volts. The battery is:

_____ a. good
_____ b. marginal
_____ c. bad

38. The battery voltage stabilized at 8.4 volts. The battery is:

_____ a. good
_____ b. marginal
_____ c. bad

39. When you use bulk electrolyte, the plastic bag of electrolyte should be:

_____ a. taken out of the container
_____ b. left in the container

40. When you fill a battery with electrolyte, the cells should be filled:

_____ a. halfway to the split ring, then filled with water
_____ b. to the top of the cell
_____ c. to the split ring in the cell

41. When you fill a battery with electrolyte from a bulk container, the battery should be:

_____ a. below the container
_____ b. above the container
_____ c. at the same level as the container

42. Place a check mark beside all of the things you would need to do after filling a dry-charged battery with electrolyte.

_____ a. Wet charge the battery.
_____ b. Slow charge the battery.
_____ c. Check the specific gravity.
_____ d. Do a 3-minute charge test.

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 4

1. Why shouldn't you touch the ground cable clamp to a terminal?

   _____

   _____

   _____

2. What are two types of equipment that can be used for the battery drain test?

   _____ and _____

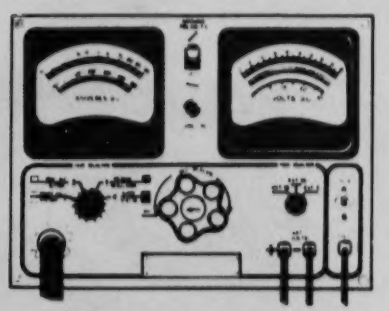
3. When is it safe to reconnect the ground cable clamp?

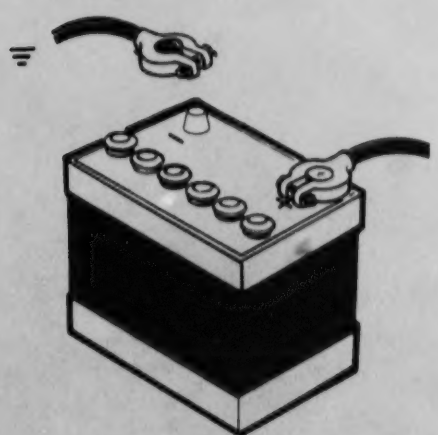
   _____

4. The battery drain test checks for loss of current in the _____ .

5. The battery leakage test checks for loss of current across the _____ .

6. In the illustration below, draw the correct hookup arrangement for the battery drain test.





7. List the action you should take when you get the following readings on the battery drain test:

Reading	Action
a. 0.0 volts	_____
	_____
	_____
b. 2.1 volts	(1) _____
	_____
	(2) _____
	_____
	(3) _____
	_____

8. The battery tests you have conducted so far have told you several important things about the battery and cranking system.
   - The battery is clean and dry.
   - There is no current leakage across the battery top.
   - All electrical equipment in the vehicle is turned off.
   - There is a current drain somewhere in the system.

   Now you should:

   _____ a. continue testing the battery
   _____ b. replace the battery
   _____ c. clean the battery
   _____ d. conduct no further battery tests and check with your instructor

9. Listed below are the steps for obtaining specific gravity readings on the hydrometer. Complete each of the statements.

   a. _____ the cell caps.

   b. _____ the bulb on the hydrometer.

   c. Put the _____ into the first cell.

   d. Slowly _____ the bulb until the _____ rises and floats freely. The float shouldn't touch the tube anywhere.

   e. Read the _____ of the hydrometer float at the electrolyte level while you hold the hydrometer at the _____ level.

   f. Put the hydrometer tip into the cell hole, but _____ the electrolyte level. Then _____ the bulb.

   g. Repeat steps _____ for each cell.

10. What do you need to do in order to obtain true adjusted specific gravity readings?

    Add _____

    _____

    Subtract _____

    _____

11. You have a reading of twelve twenty (1.220) and an electrolyte temperature of 90° F. on the hydrometer. What is the specific gravity?

    _____

WORK SPACE

12. You have a reading of twelve twenty (1.220) and an electrolyte temperature of 70° F. on the hydrometer. What is the specific gravity?

_____

WORK SPACE

13. You have a reading of twelve twenty (1.220) and an electrolyte temperature of 75° F. on the hydrometer. What is the specific gravity?

_____

WORK SPACE

14. You have a reading of twelve twenty (1.220) and an electrolyte temperature of 80° F. on the hydrometer. What is the specific gravity?

_____

WORK SPACE

15. You have a reading of twelve twenty (1.220) and an electrolyte temperature of 65° F. on the hydrometer. What is the specific gravity?

_____

WORK SPACE

16. You have a reading of twelve twenty (1.220) and an electrolyte temperature of 100° F. on the hydrometer. What is the specific gravity?

_____

WORK SPACE

17. The specific gravity of five of the cells is twelve seventy-six (1.276). In the same battery the specific gravity of one of the cells is eleven thirty-six (1.136). Will the battery accept and hold a charge?

_____

WORK SPACE

18. The specific gravity of four of the cells is twelve eighty (1.280). In the same battery the specific gravity of another cell is twelve forty (1.240), and the last cell has the specific gravity of twelve twenty (1.220). Will the battery accept and hold a charge?

_____

WORK SPACE

Use this table to help you answer questions 19 and 20.

Specific Gravity	Charge State	
1.280	100%	
1.250	75%	
1.220	50%	
1.190	25%	needs
1.160	very little charge	to be
1.130	discharge	charged

19.

Cell	Specific Gravity
1	1.276
2	1.276
3	1.246
4	1.196
5	1.166
6	1.276

Will the battery accept and hold a charge? _____

WORK SPACE

41

20.

Cell	Specific Gravity
1	1.250
2	1.250
3	1.270
4	1.270
5	1.250
6	1.270

a. Does the battery need charging?

_____

b. Will the battery accept and hold a charge?

_____

WORK SPACE

Now turn to the back of this book and check your answers for Exercise 4.

12

EXERCISE 5

1. List the safety practices to follow ***before*** you attempt to charge a battery.

   a. External battery defects _____

   _____

   b. Vent caps _____

   c. Room temperature _____

   d. Disconnecting and reconnecting battery cable clamps _____

   _____

   _____

   e. On-off switch for battery charger _____

   f. Ventilation _____

   g. Concrete and wood _____

   _____

   h. Water _____

   i. Equipment and manufacturer's instructions _____

   _____

2. List the safety practices to follow ***during*** the battery charging.

   a. Electrolyte temperature _____

   b. Specific gravity _____

   c. Battery voltage _____

   d. Equipment manufacturer's instructions _____

3. Is a slow charge the only way to fully charge a battery?

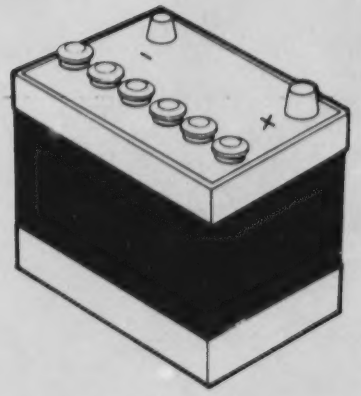
   _____ a. yes
   _____ b. no

4. Is a slow charge the safest way to charge a battery?

   _____ a. yes
   _____ b. no

5. In the illustration below, draw the connections used for slow charging.

CHARGER



6. A battery with a 90-ampere-hour rating needs a slow charge. What is the correct charging rate? _____

WORK SPACE

7. You've been charging the battery for 15 minutes. The electrolyte temperature is 127° F. What should you do?

_____

8. You've been slow charging a battery with low specific gravity readings. The specific gravity for cells 1 through 5 is 1.190, and the specific gravity for cell 6 is 1.200. The readings have been the same for three hours. What should you do?

_____

_____

Why? _____

_____

_____

_____

9. The specific gravity for cells 1 and 2 is 1.200, and the specific gravity for the other cells is 1.225. This is the second hour of slow charging. What should you do?

_____

Why? _____

_____

_____

_____

10. The specific gravity of all cells is 1.250. This is the fourth hour of slow charging, and the readings have been increased each hour. What should you do?

_____

Why? _____

Now turn to the back of this book and check your answers for Exercise 5.

EXERCISE 6

1. A 3-minute charge test should be performed (place a check mark beside all of the correct answers):
   _____ a. before slow charging a battery
   _____ b. when there is no reading on the hydrometer when you test specific gravity
   _____ c. before fast charging any battery
   _____ d. before checking specific gravity

2. Before charging a battery, you should do the following (complete each of the sentences):

   a. Be sure the vent caps are _____ and the vent holes are

   _____ .

   b. Be sure to _____ the battery cable clamps.

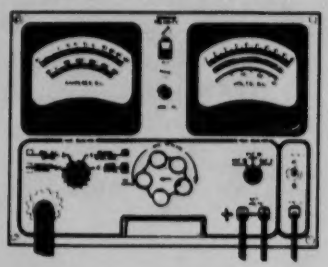
   c. _____ the battery from the vehicle.

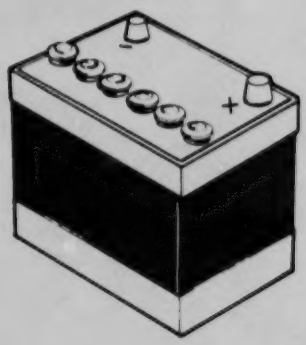
   d. Set the battery on a _____ block, shelf, or table.

3. Never do a 3-minute charge test or fast charge a battery that has (place a check mark beside all of the correct answers):
   _____ a. clogged vent holes
   _____ b. its vent caps removed
   _____ c. a bulging case
   _____ d. ice crystals in the electrolyte
   _____ e. water in the electrolyte
   _____ f. gassing or spraying electrolyte
   _____ g. acid in the electrolyte

4. In the illustration below, draw the charging and voltmeter leads to show how the voltmeter and battery charger are connected to the battery for the 3-minute charge test.

BATTERY
CHARGER





5. Before connecting the charger or voltmeter leads, be sure that:
   _____ a. the charger is turned off
   _____ b. the charger is turned on
   _____ c. the voltmeter leads are connected first

6. The highest recommended charging rate for the 3-minute charge test is:
   _____ a. 55 amps
   _____ b. 50 amps
   _____ c. 45 amps
   _____ d. 40 amps

7. Should you turn the battery charger on before or after you connect the charger leads?
   _____ a. before
   _____ b. after

8. After you start the 3-minute charge test, what should you do about the voltage readings?

_____

_____

9. Place a check mark beside the voltage readings that are too high for safety.

_____ a. 1.190 volts
_____ b. 1.250 volts
_____ c. 15.0 volts
_____ d. 15.5 volts
_____ e. 20.5 volts

10. If you find high voltage readings or spraying or boiling electrolyte during the 3-minute charge test, you should:

_____ a. stop the test
_____ b. decrease the rate of charge
_____ c. increase the time for charging

11. When you stop the 3-minute charge test, should you turn off the charger before or after you disconnect the leads?

_____ a. before
_____ b. after

12. These are the results of a 3-minute charge test:

- the voltage reading is 15.5 volts after one minute
- the battery electrolyte is gassing.

What should you do?

_____

13. At the end of the 3-minute charge test, the voltage is 15.9 volts. What should you do?

_____

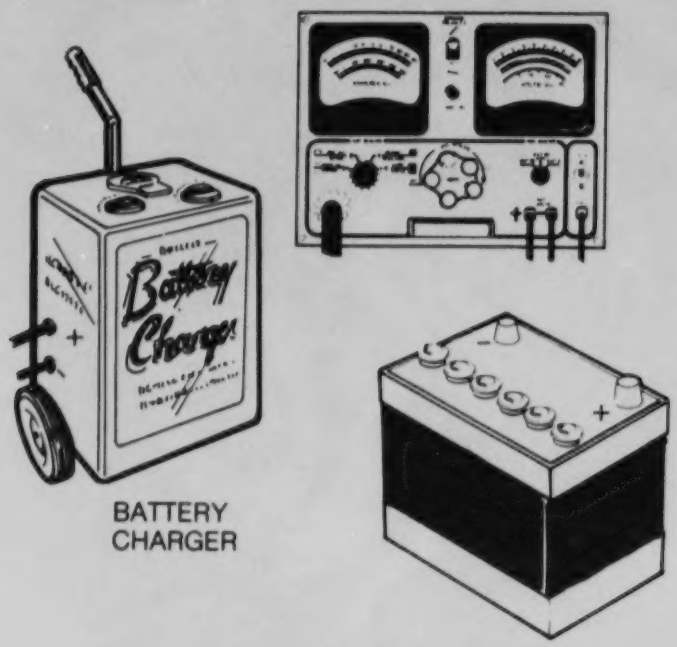
14. It's safe to charge the battery when (complete all of the following statements):

a. the voltage readings stay _____ during the 3-minute charge test.
b. the electrolyte doesn't _____ during the 3-minute charge test.
c. the voltage is _____ at the end of the 3-minute charge test.

15. Never fast charge a battery that has (place a check mark beside all of the correct answers):

_____ a. passed the 3-minute charge test
_____ b. failed the 3-minute charge test
_____ c. defective internal or external parts
_____ d. boiling, gassing, or spraying electrolyte
_____ e. low temperature and voltage readings

16. In the illustration below, draw the battery charger leads to show how they are connected to the battery during fast charging.



BATTERY
CHARGER

17. What is the highest recommended rate for fast charging a battery?

_____

Use this chart to help you answer questions 18-21.

	Specific Gravity	Length of Fast Charge
(low charge state)	1.150 or less	45 minutes–1 hour
	1.150–1.175	30–45 minutes
	1.175–1.200	15–30 minutes
	1.200–1.225	0–15 minutes
(high charge state)	1.225 or more	Do not fast charge; slow charge only.

18. How long should a battery with a specific gravity reading of about 1.210 be charged?

    _____ Is it safe to fast charge the battery? _____

19. How long should a battery with a specific gravity reading of about 1.160 be charged?

    _____ Is it safe to fast charge the battery? _____

20. How long should a battery with a specific gravity reading of about 1.280 be charged?

    _____ Is it safe to fast charge the battery? _____

21. How long should a battery with a specific gravity reading of about 1.225 be charged?

    _____ Is it safe to fast charge the battery? _____

22. When fast charging a battery, you should check the electrolyte temperatures:

    _____ a. at the end of the first hour
    _____ b. immediately and often
    _____ c. at the end of the first half hour
    _____ d. at the end of the fast charge

23. You have just started fast charging a battery. How are you going to check the voltage?

    _____

    _____

24. You plan to fast charge a battery for 45 minutes. The specific gravity is about 1.150. You have now been fast charging the battery for 15 minutes and find that:
    - the electrolyte temperature is 125° F.
    - the voltage is 15.5 volts.

    What should you do?

    _____

    _____

25. You have decreased the rate of charge, but the electrolyte temperature stays at 125° F. and the voltage stays near 15.5 volts. What should you do?

    _____

26. When should you stop the fast charge?

    a. _____

    OR

    b. _____

27. Should you disconnect the charger leads before or after turning off the charger?

    _____

28. When you've finished fast charging the battery, what can you do to fully charge it?

    _____

29. The general procedure to follow when doing the battery capacity test is to (complete all of the following statements):

    a. determine the _____ needed for the test.

    b. apply the _____ by turning the control knob.

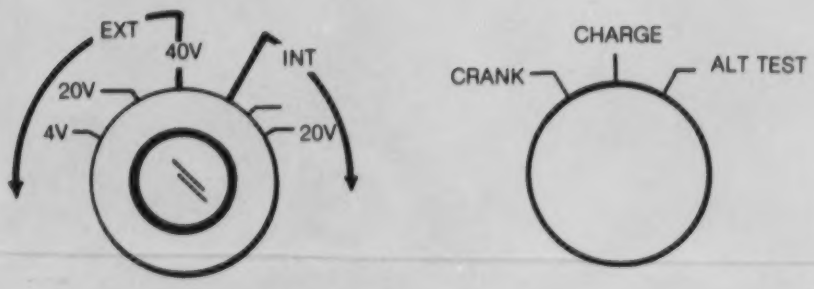
    c. read the meter on the _____ .

    d. use the test results to determine the condition of the _____ .

30. To connect the battery tester, you should (place a check mark beside all of the correct answers):

    _____ a. follow the tester manufacturer's instructions
    _____ b. attach the red lead to the positive battery terminal
    _____ c. attach the black lead to the negative battery terminal
    _____ d. be sure the tester is turned off before you connect the leads
    _____ e. attach the tester leads according to the proper polarity

31. In the illustration below, mark the position for the test selector knobs during the battery capacity test.



32. A battery has a 100-ampere-hour rating.

a. What load should you apply to test the battery capacity?

_____

WORK SPACE

b. To apply the load during the test, turn the _____ knob until the meter shows _____ amps.

c. How long should you keep the load on? _____

d. What would happen if you kept the load on longer?

_____

33. A battery has a load-test amp rating of 235.

a. How much load should you apply to test the battery capacity? _____

b. How long should you apply the load? _____

Use this chart to answer questions 34-36.

ENGINE DISPLACEMENT	LOAD
Over 300 CID	235 amps
Under 300 CID	200 amps
Most 4- and 6-cylinder	170 amps

34. The engine has 275 CID. What load should you apply to test the battery capacity?

    _____

35. The engine has 325 CID. What load should you apply to test the battery capacity?

    _____

36. The vehicle you're working on is a 1974 Mustang V6. What is the load you need to apply to test the battery capacity? _____

37. When should you look at the voltmeter during the battery capacity test?

    _____

38. A battery capacity test using the ampere-hour rating to determine load had these results:
    - the voltmeter stayed steady at 9.6 volts for 5 seconds
    - the voltmeter stayed steady at 9.1 volts for 10 seconds.

    The battery was charged before this test. What is the condition of the battery?

    _____

39. During a battery capacity test using the load-test amp rating, the voltmeter stayed steady at 9.8 volts for about 15 seconds. What is the condition of the battery?

    _____

40. For these three questions, assume that engine displacement was used to determine the load for the battery capacity test, and the load was applied for 15 seconds. In addition, each of the batteries was charged before the battery capacity was tested.

    a. The voltmeter stayed steady at 9.5 volts. What is the condition of the first battery?

    _____

    b. The voltmeter stayed steady at 9.7 volts. What is the condition of the second battery?

    _____

    c. The voltmeter stayed steady at 8.9 volts. What is the condition of the third battery?

    _____

41. If the voltage stays at _____ volts or at more than _____ volts during the battery capacity test, the battery is in good condition.

42. If the voltage is less than _____ volts during the battery capacity test, the battery has failed the test.

43. Suppose the battery wasn't charged before doing the battery capacity test. What would you need to do if the test results showed that the battery failed the test?

    _____

44. What should you do if the battery capacity test results are marginal and you still have cranking problems?

    _____

45. Is it better to charge the battery before or after doing the battery capacity test?

    _____ Why? _____

    _____

Now turn to the back of this book and check your answers for Exercise 6.

EXERCISE 7

1. What is a dry-charged battery?_____

   _____

2. What ampere-hour rating should a dry-charged battery have when it's replacing a defective 80-ampere-hour battery? _____

3. When should you activate a dry-charged battery? _____

   _____

4. Place a check mark beside all of the safety practices that you'll need to follow when you work with packaged electrolyte.

   _____ a. If electrolyte gets in your eyes, squirt water or milk in them for at least two minutes.
   _____ b. If electrolyte gets in your eyes, contact a doctor immediately.
   _____ c. If electrolyte gets on your skin, rinse your skin with baking soda and water or milk.
   _____ d. Wear rubber gloves.
   _____ e. Wear a rubber apron.
   _____ f. Wear eye protection.
   _____ g. Wear a helmet and face guard.
   _____ h. Wear a protective mask.
   _____ i. Be careful not to spill or splash electrolyte.
   _____ j. Don't leave open packages of electrolyte lying around.
   _____ k. Follow the directions on the package of electrolyte.

5. When you open a small electrolyte package, you should:

   _____ a. cut a large hole in the plastic bag to make it easy to pour the electrolyte
   _____ b. cut a very small opening in the electrolyte bag
   _____ c. cut two holes in the electrolyte bag to make it easier to pour the electrolyte

6. When you fill the battery with electrolyte, you should (place a check mark beside all of the correct answers):

   _____ a. use a metal funnel
   _____ b. use a glass funnel
   _____ c. use a plastic funnel
   _____ d. use an acid-proof funnel

7. As you pour electrolyte into each battery cell, you should (complete all of the statements below):

   a. _____ the vacuum seal on each cell.

   b. pour only a _____ electrolyte at a time into each cell.

c. fill each cell only to the _____ .

d. _____ overfill the battery cells.

8. What should you do to the vent caps after you have filled each battery cell?

_____

9. What should you do to the battery if some electrolyte spills on it?

_____

10. After you have filled the battery cells from a small electrolyte package, you should (complete all of the statements below):

a. _____ the package.

b. _____ the package inside and out.

c. _____ the package.

11. After you have used all of the contents of a bulk electrolyte package to fill the cells, you should (complete all of the statements below):

a. _____ the plastic bag inside and out.

b. _____ the bag.

c. _____ the package.

12. What should you do to the bulk electrolyte package if, after filling the battery cells, a lot of electrolyte is left in the package? (Complete all of the statements below.)

a. _____ the clamp and stand the container _____ .

b. Place the siphon tube _____ the container.

c. Store the container in a _____ place.

13. When you open a new bulk electrolyte package, you should (place a check mark beside all of the correct answers):

_____ a. pull the tab on top of the container
_____ b. use a knife to slit open the container
_____ c. pull out the siphon tube
_____ d. remove the plastic bag
_____ e. remove the cap from the plastic bag inside the container
_____ f. screw the cap at the end of the siphon tube onto the opening in the plastic bag
_____ g. close the spring clamp on the siphon tube
_____ h. lay the container on its side on the floor before you fill the battery

14. What two basic steps do you need to complete after you fill a battery with the electrolyte?

a. _____

b. _____

Now turn to the back of this book and check your answers for Exercise 7.

PERFORMANCE CHECKLIST—P.O. 1

The instructor will provide either a live vehicle with a battery or a shop battery for this objective. All necessary tools, equipment, and manuals must be made available.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Determines the electrolyte level and adds water as needed. (Omit if battery is sealed case type.)			
2. Visually inspects the battery case, cables, and hold-down brackets, and takes appropriate action.			
3. Removes, cleans, dries, and reinstalls the battery. Replaces any defective parts as needed.			
4. Performs the battery drain and leakage tests, and takes appropriate action.			
5. Finishes installation of the battery. Lubricates the terminals with the appropriate lubricant.			
6. Checks the specific gravity and takes appropriate action. (Omit if battery is sealed case type.)			
*7. Performs a slow charge, 3-minute charge test, or fast charge as needed.			
*8. Performs the battery capacity test and takes appropriate action.			
*9. Activates a dry-charged battery.			
10. Performs an operational check.			
11. Uses proper tools and equipment.			
12. Follows all safety precautions.			
13. Time.			

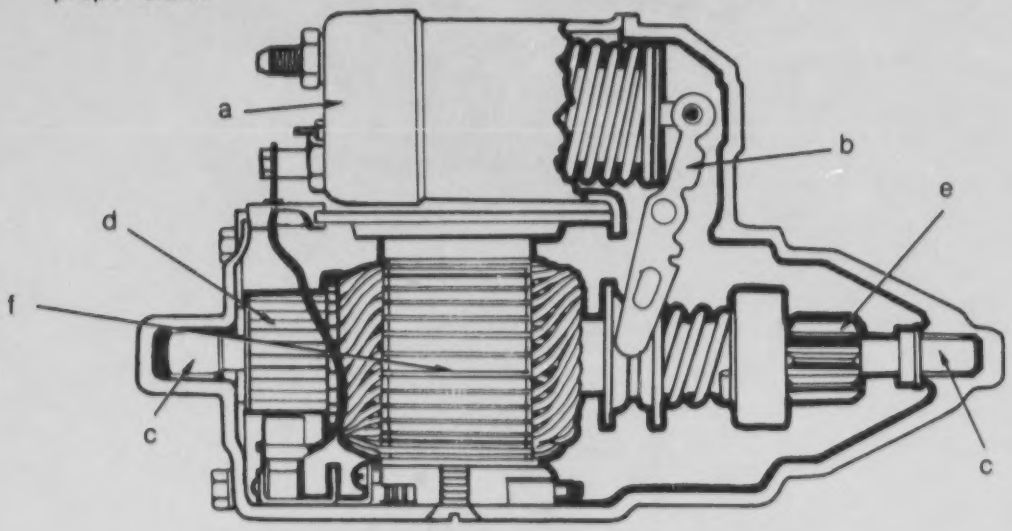
*Note: If the shop battery is to be used for all students, instead of actually performing items identified with *, a student could only go through the motions (for example, hook up the charger and describe the procedure from there).

Keep this checklist for your records.

P.O. 2 PRETEST

NAME _____

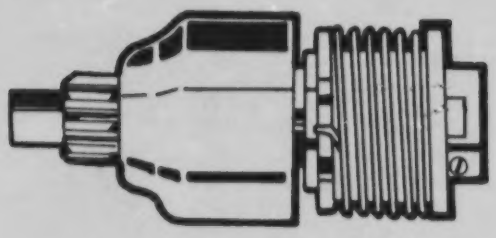
1. Identify each of the parts in the picture by writing the number of the correct part name in the proper blank.



_____ a.
_____ b.
_____ c.
_____ d.
_____ e.
_____ f.

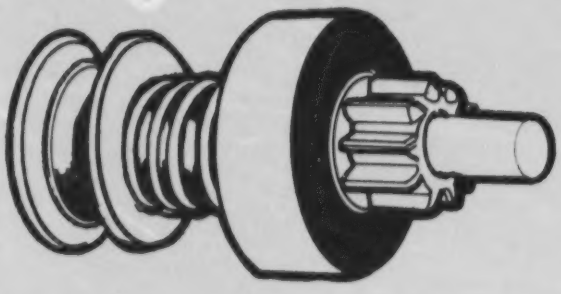
1. shift fork
2. armature
3. coil assembly
4. solenoid
5. relay mechanism
6. pinion gear
7. bushings
8. commutator
9. brushes

2. The type of drive mechanism illustrated below is:



_____ a. a Bendix drive
_____ b. an overrunning clutch drive
_____ c. a solenoid drive
_____ d. a relay drive

3. The type of drive mechanism illustrated below is:



_____ a. a Bendix drive
_____ b. an overrunning clutch drive
_____ c. a solenoid drive
_____ d. a relay drive

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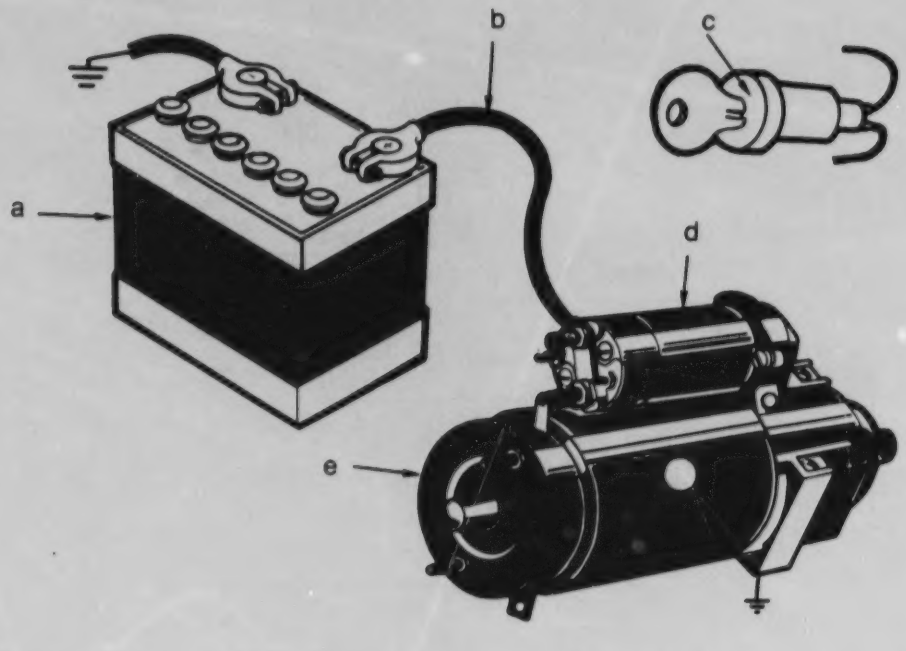
4. Identify the lettered components of the cranking circuit below.



a. _____

b. _____

c. _____

d. _____

e. _____

5. The _____ gear is located on the cranking motor.

_____ a. eccentric
_____ b. nose
_____ c. castellated
_____ d. pinion

6. The cranking motor gear meshes with the _____ gear.

_____ a. neutral safety
_____ b. starter Bendix
_____ c. clutch drive
_____ d. flywheel ring

7. This larger gear is mounted on the engine:

_____ a. crankshaft
_____ b. Bendix drive
_____ c. camshaft
_____ d. flywheel

8. The engine turns over because the _____ is turned by the cranking motor.

_____ a. Bendix drive
_____ b. crankshaft
_____ c. flywheel
_____ d. camshaft

9. The flywheel is mounted to the engine:

_____ a. camshaft
_____ b. driveshaft
_____ c. armature shaft
_____ d. crankshaft

10. The cranking motor disengages when the engine starts because of the _____ mechanism.

_____ a. armature or field coil
_____ b. Bendix drive or overrunning clutch
_____ c. relay or solenoid

11. The cranking motor is started when the cranking motor switch:

_____ a. closes the circuit from the ignition switch to the battery
_____ b. opens the circuit from the ignition switch to the battery
_____ c. opens the circuit from the battery to the cranking motor
_____ d. closes the circuit from the battery to the cranking motor

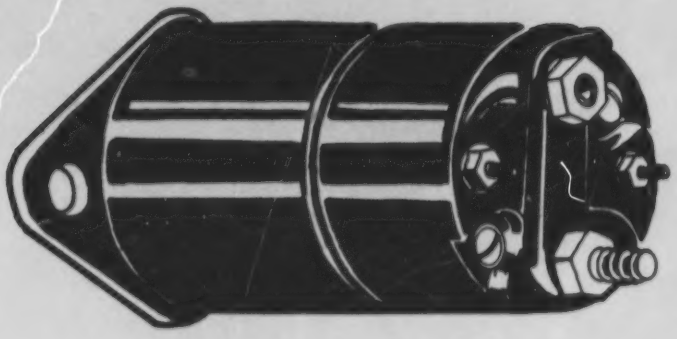
12. The driver of the vehicle is able to control the operation of the cranking motor with the:

_____ a. ignition switch
_____ b. auxiliary switch
_____ c. circuit breaker switch
_____ d. relay switch

13. Most vehicles cannot be started while in gear. This is because of the _____ switch:

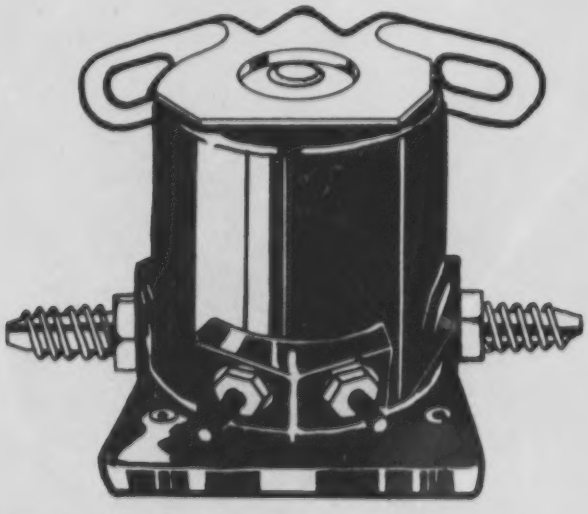
_____ a. ignition
_____ b. neutral safety or clutch start
_____ c. circuit breaker
_____ d. solenoid or relay

14. The cranking motor switch illustrated below is:



_____ a. a starter relay
_____ b. a starter solenoid

15. The cranking motor switch illustrated below is:



_____ a. a starter relay
_____ b. a starter solenoid

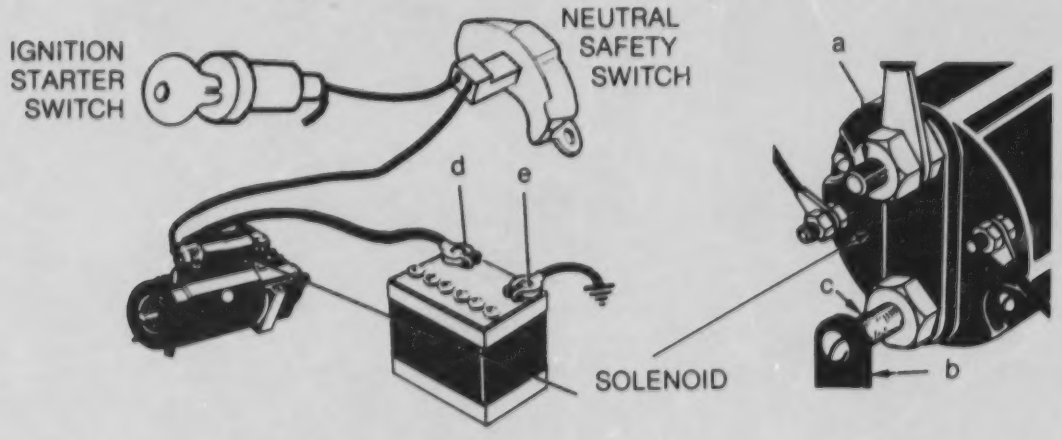
For questions 16-20, give one possible defect for each part of the cranking circuit listed.

	Defect
16. Battery and/or cable connections	_____
17. Cranking motor	_____
18. Cranking motor drive	_____
19. Controls and switches	_____
20. Flywheel and ring gear	_____

21. List the correct sequence for testing the cranking system by placing the letter of each test in the blank beside the proper number.

Steps	Tests
_____ 1.	a. battery
_____ 2.	b. starter draw
_____ 3.	c. continuity
_____ 4.	d. voltage drop

Use the diagram below to find the parts described in questions 22-26. Place the letter of each part in the proper blank.



22. Which terminal on the solenoid is the motor terminal? _____
23. Which terminal on the solenoid is the battery terminal? _____
24. Which cable clamp on the battery is the positive battery cable clamp? _____
25. Which cable clamp on the battery is the negative battery cable clamp? _____
26. Which terminal on the cranking motor is the motor terminal? _____

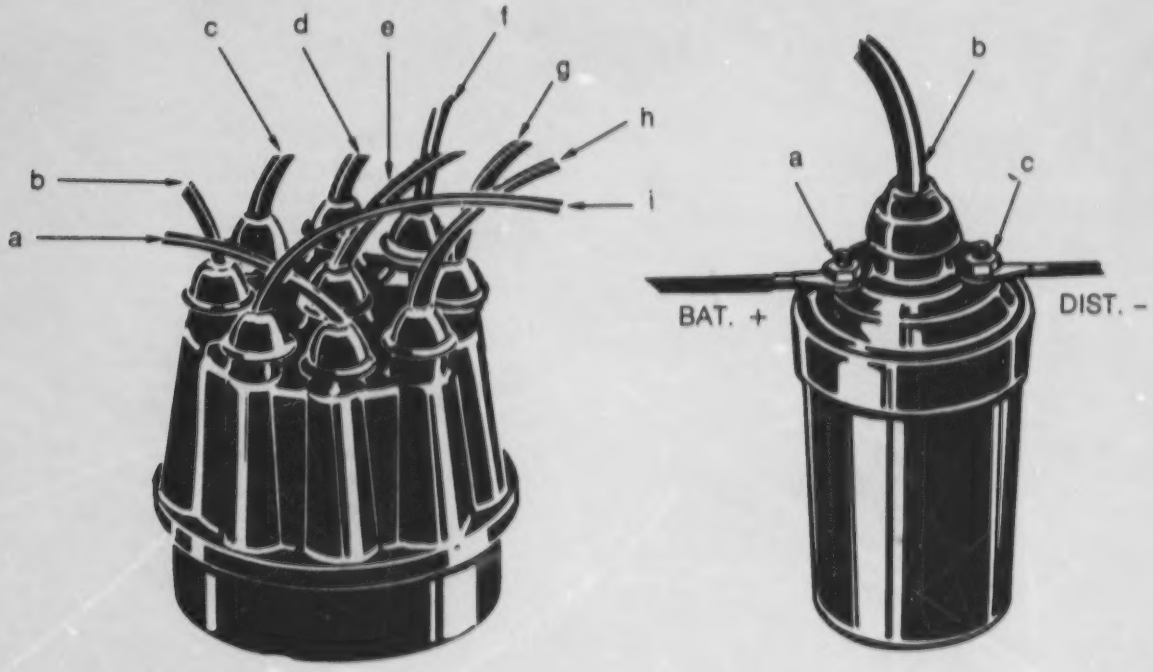
Using the illustration below, write the letter of the cable that should be disconnected in order to disable the ignition.

27. the distributor _____

    Should you ground this cable? _____

28. the ignition coil _____

    Should you ground this cable? _____



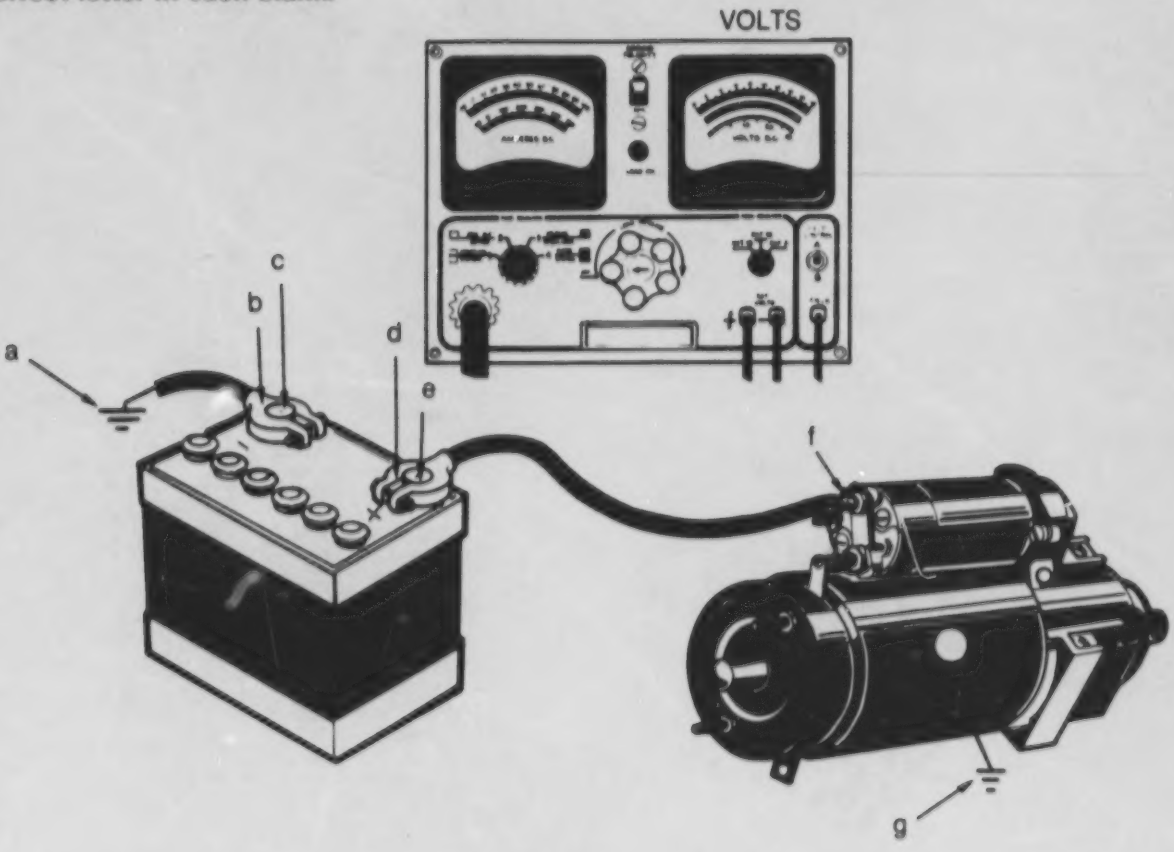
For questions 29-31 write the correct letter of the equipment listed below that is required for the tests given.

Tests		Equipment
29. Continuity test (two types of equipment)	(1) _____ (2) _____	a. starting-charging systems tester b. ammeter c. low voltage test light d. ohmmeter e. voltmeter with low voltage scale
30. Starter draw test	_____	
31. Voltage drop test	_____	

32. The steps listed below for making a voltage drop test are out of order. Write the letter of each step in the blank beside the proper number to show the correct sequence.

Order	Steps
_____ 1.	a. Disable the ignition.
_____ 2.	b. Take a meter reading.
_____ 3.	c. Compare the reading with the manufacturer's specifications.
_____ 4.	d. Connect the meter leads.

For questions 33-37, assume that you are making a voltage drop test. Each question defines a possible test result. Use the illustration below to complete each question by writing the correct letter in each blank.



33. Voltage drop from the positive battery cable clamp to the solenoid motor terminal

    Put the positive (+) meter lead at _____.
    Put the negative (–) meter lead at _____.

34. Voltage drop from the positive terminal post to the positive cable clamp on the battery

    Put the positive (+) meter lead at _____.
    Put the negative (–) meter lead at _____.

35. Voltage drop from the solenoid battery to the solenoid motor terminal

    Put the positive (+) meter lead at _____.
    Put the negative (–) meter lead at _____.

36. Voltage drop from the positive battery cable clamp to the solenoid battery terminal

    Put the positive (+) meter lead at _____.
    Put the negative (–) meter lead at _____.

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37. Voltage drop from negative battery cable clamp to ground

Put the positive (+) meter lead at _____ .
Put the negative (–) meter lead at _____ .

38. Excessive (too much) voltage in a voltage drop test means that there is:

_____ a. low resistance in the circuit
_____ b. low amperage in the circuit
_____ c. high resistance in the circuit
_____ d. high amperage in the circuit

39. The most likely cause of excessive voltage loss in a voltage drop test is:

_____ a. defective component(s)
_____ b. incorrectly-sized wires
_____ c. loose or corroded connections
_____ d. low battery capacity
_____ e. excessive amperage through the circuit

40. A continuity test will show whether:

_____ a. the resistance in a circuit is too low
_____ b. there is current flow in a circuit
_____ c. the amperage in a circuit is too high

41. The starter draw test measures how much:

_____ a. resistance is in the cranking motor
_____ b. resistance is in the solenoid
_____ c. amperage is used when cranking the engine
_____ d. voltage is used when cranking the engine

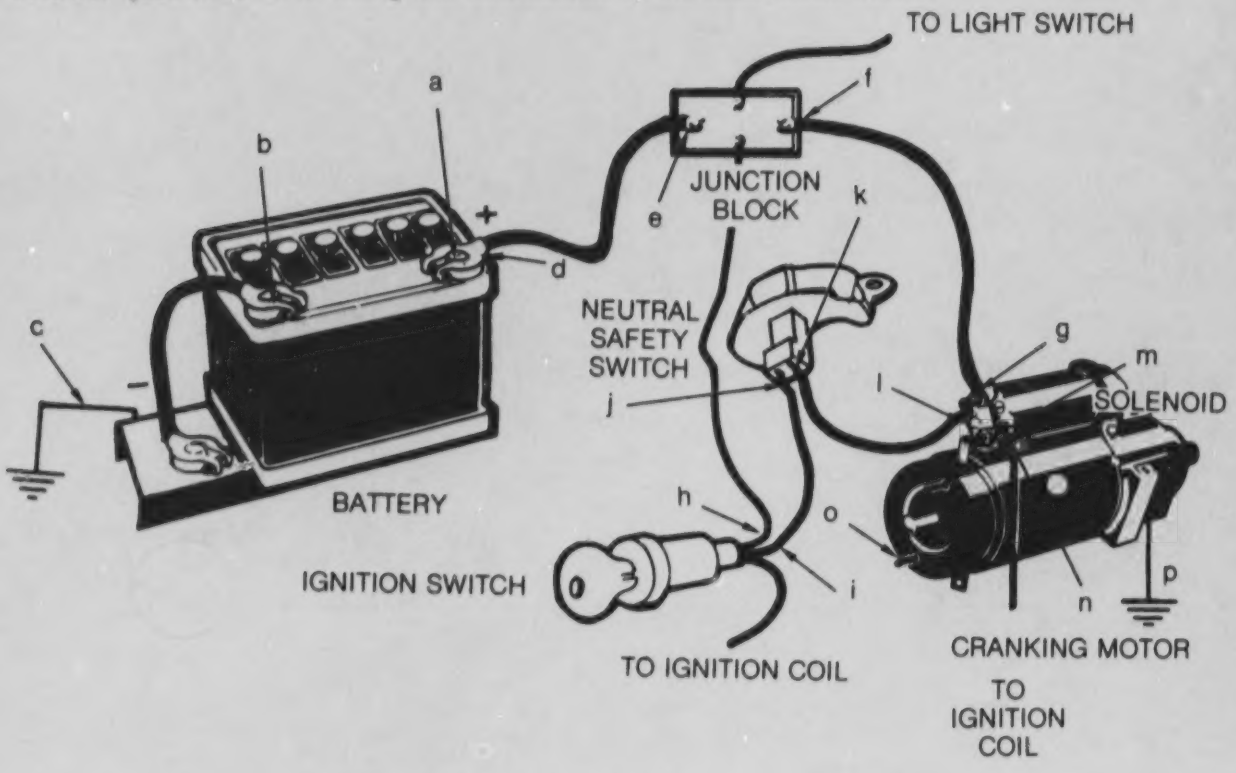
42. Ordinarily, you would not make a starter draw test unless:

_____ a. the battery was defective
_____ b. the cranking motor turned the engine over slower than normal
_____ c. the cranking motor turned the engine over faster than normal
_____ d. the voltage drop test indicated excessive solenoid resistance
_____ e. the continuity test indicated an open portion in the cranking circuit

43. Place a check mark beside all of the safety practices listed below that you should follow.

_____ a. Disable the ignition before making any electrical tests.
_____ b. Rely on your memory for correct tester hook-ups.
_____ c. Avoid making any electrical tests in or around wet areas.
_____ d. Route tester leads away from moving engine parts.
_____ e. Look before reaching into an operating engine.

Answer questions 44-47 using the information in the illustration below.



44. Voltage is detected from points ***a*** to ***b***. Therefore:

_____ a. the ground circuit is in good condition
_____ b. the ground circuit is defective
_____ c. the battery has power
_____ d. the battery has no power
_____ e. there is voltage loss in the battery

45. Voltage is detected from points ***c*** to ***e***, but no voltage is found from ***c*** to ***f***. Therefore:

_____ a. the neutral switch is broken
_____ b. the ignition switch is defective
_____ c. the junction block is defective
_____ d. the ground circuit is defective

46. If there is voltage from points ***c*** to ***g***, but no voltage from ***c*** to ***l***, which of the following could ***not*** be the reason?

_____ a. The solenoid is defective.
_____ b. The ignition is not turned on.
_____ c. The ignition switch is defective.
_____ d. The junction block connections are defective.
_____ e. The neutral safety switch is defective.

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47. If there is voltage from points *c* to *g*, but no voltage from *c* to *j*, what is wrong?

_____ a. The battery has no power.
_____ b. The ignition switch is defective.
_____ c. The cranking motor is poorly grounded.
_____ d. The battery clamps need tightening.
_____ e. The neutral safety switch is defective.

48. The steps listed below for making a starter draw test are out of order. Write the letter of each step in the blank beside the proper number to show the correct sequence.

Order	Steps
_____ 1.	a. Crank the engine.
_____ 2.	b. Turn the load control knob until the voltage is the same as when the engine was cranking.
_____ 3.	c. Read the voltage.
_____ 4.	d. Hook up the tester leads.
_____ 5.	e. Read the ammeter.
_____ 6.	f. Disable the ignition.
_____ 7.	g. Stop cranking the engine.

49. Look at this table of starter draw test readings, possible conditions, and possible actions.

Starter Draw Test Readings

Engine	Reading	Possible Conditons	Possible Actions
large GMC V-8	250 amps	too high	a. No action is needed.
other V-8s	200 amps	too low	b. Check the battery.
all 6-cylinder	180 amps	okay	c. Check the solenoid.
			d. Check the cranking motor.
			e. Check the circuit for excessive resistance.
			f. Check the neutral safety switch.

Using the above information, write the ***condition*** of the cranking system and the letter of the correct action to take for these readings.

Engine	Reading	Condition	Action
1. 6-cylinder AMC	120 amps	_____	_____
2. 8-cylinder Ford	200 amps	_____	_____
3. Large GMC V-8	290 amps	_____	_____
4. 8-cylinder Chrysler	210 amps	_____	_____

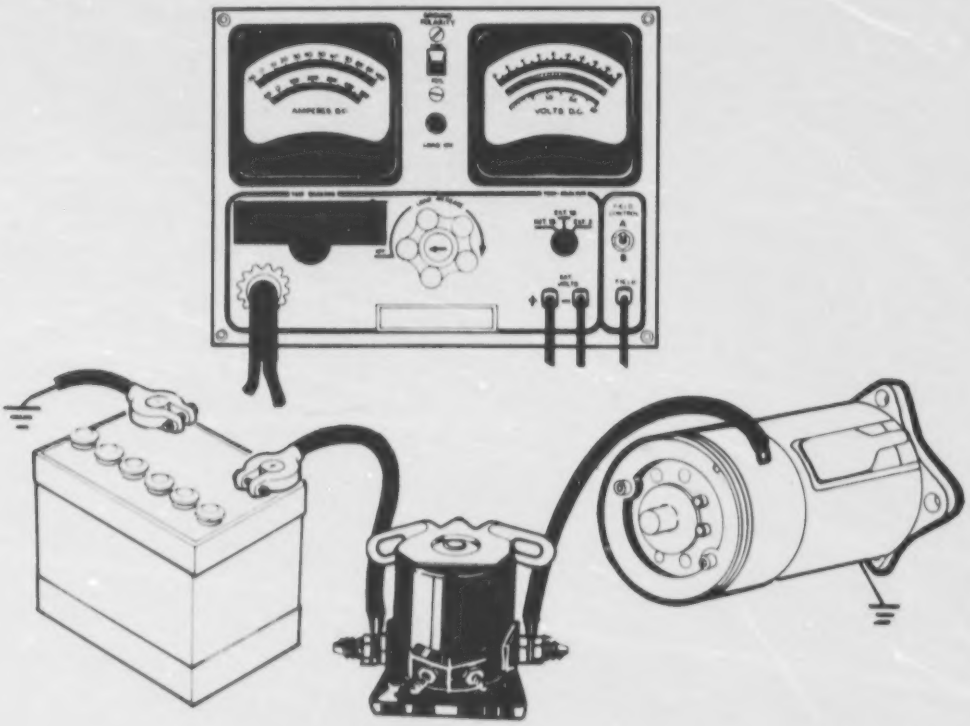
Refer to this table of voltage drop test readings, possible conditions, and possible actions when you answer questions 50-54.

Maximum Voltage Drop Test Readings		Possible Conditions	Possible Actions
Circuits	Acceptable Voltage Reading	too high OR okay	a. Check the connections between the battery and ground and between the ground and engine.
between the solenoid battery and solenoid motor terminals	0.3 v		b. Check the cables and connections between the battery post and the solenoid battery terminal.
between the positive battery cable clamp and solenoid motor terminal	0.5 v		c. Check the solenoid.
between the negative battery cable clamp and ground	0.1 v		d. Check the cranking motor.
between each terminal post and cable clamp on the battery	0.0 v		e. Check the clamps and posts on the battery.
between the positive battery cable clamp and the solenoid battery terminal	0.2 v		f. Check the battery amperage.
			g. No action is needed.

Using the above information, write the condition of the cranking system and write the letter of the correct action to take for these readings.

Test	Voltage	Condition	Action
50. Between the solenoid battery and the solenoid motor terminals	.4 v	_____	_____
51. Between the positive battery cable clamp and the solenoid motor terminal	.6 v	_____	_____
52. Between the negative battery cable clamp and ground	.05 v	_____	_____
53. Between each terminal post and clamp on the battery	.01 v	_____	_____
54. Between the positive battery cable and the solenoid battery terminal	.2 v	_____	_____

55. Draw the correct equipment hookup for making a starter draw test.



When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 8

1. The cranking motor receives power from the _____.

2. The cranking motor pinion gear turns the _____.

3. The pinion gear is part of:

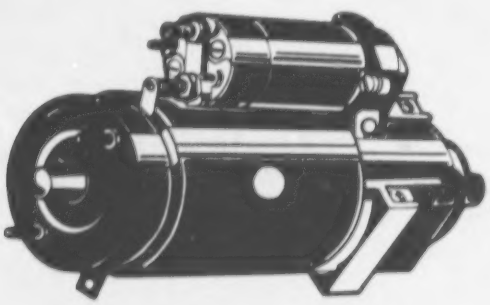
   _____ a. the flywheel
   _____ b. the starter switch
   _____ c. the cranking motor drive
   _____ d. the ring gear

4. The crankshaft can begin to turn when the _____ gear is fully meshed (engaged) with the flywheel _____ attached to the flywheel.

5. For each statement below, write *T* (for true) or *F* (for false) in the blank.

   _____ a. The solenoid is larger than the starter relay.
   _____ b. The solenoid operates in basically the same way as the starter relay.
   _____ c. The solenoid is usually used with overrunning clutch drive mechanisms.
   _____ d. The solenoid is located on top of the cranking motor.
   _____ e. The starter relay is usually located apart from the cranking motor.
   _____ f. Current flows from the ignition switch to the solenoid.
   _____ g. Current flows from the battery to the cranking switch.

6. The figure below is an illustration of:



   _____ a. a solenoid-operated cranking motor
   _____ b. a starter relay-operated cranking motor

7. What do the neutral safety switch and the neutral or clutch start switch do?

   _____ a. They keep the vehicle from starting when it is in gear.
   _____ b. They close the circuit between the ignition start switch and the solenoid.
   _____ c. They allow the vehicle to start in neutral or park.
   _____ d. all of the above
   _____ e. none of the above

8. Current will not flow through a(n) _____ circuit.

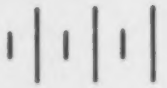
9. Current will flow through a(n) _____ circuit.

10. If there is an open switch, there is a(n) _____ circuit.

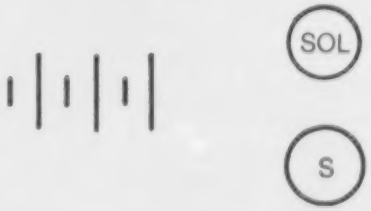
11. Name a source you can use to look up a wiring diagram.

_____

12. Show a negative-grounded battery by adding the symbol for ground to the symbol below.

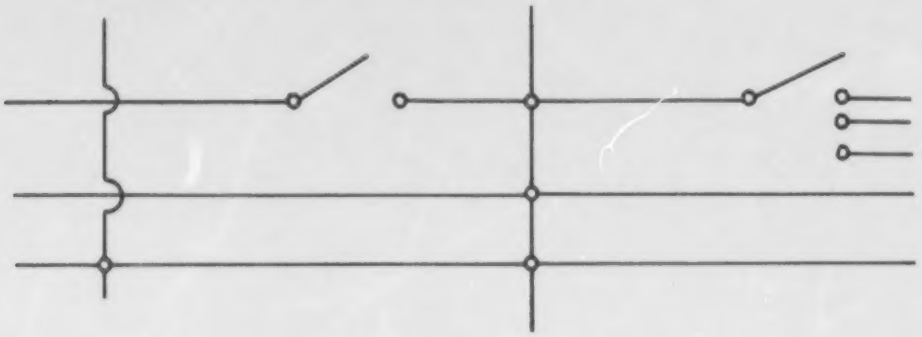


13. Complete the diagram by drawing the wiring, neutral safety switch, ignition switch, and ground symbols for the cranking circuit. Label each switch.



14. In the following diagram:

    a. circle each switch.
    b. put a square around the wires that cross and are connected to each other.
    c. put a triangle around the wires that cross each other, but are not connected.
    d. make a circle with a dotted line around each contact for a switch.



Now turn to the back of this book and check your answers for Exercise 8.

EXERCISE 9

1. How can you listen for unusual cranking sounds and crank the engine at the same time?

   _____

   _____

2. Why shouldn't you wear loose-fitting clothing when you're working on a vehicle? Why shouldn't you reach into an engine compartment without looking?

   _____

   _____

3. How can you protect the vehicle finish when you're working in the engine compartment?

   _____

4. Why shouldn't you wear metal rings when you're working in the engine compartment?

   _____

5. For each unusual cranking sound listed below, list the possible source or cause of the problem.

Unusual Sound	Possible Source or Cause of Problem
a. Clicking noise at cranking motor or starter relay	_____
b. Clanking noise at cranking motor	_____
c. Spinning sound at cranking motor	_____
d. Whining, straining, or slow, dragging sound	_____
e. Nothing but a click at the solenoid	_____
f. No sound	_____
g. Spinning or grinding sound at the flywheel	_____
h. Rumbling, rapping, or knocking sound at the flywheel	_____

Now turn to the back of this book and check your answers for Exercise 9.

EXERCISE 10

1. Match each test on the right to its description on the left.

_____ a.	a check to find how much amperage is used during cranking	1. voltage drop test 2. starter draw test 3. continuity test
_____ b.	a check to find whether current is flowing from one place to another	
_____ c.	a check to find how much voltage is used during cranking	

2. How do you check to see whether you have solved a problem in the cranking system?

_____

3. As a general guide, what part of the cranking system should you check first?

_____

4. What is the general sequence of tests performed on the cranking system?

a. _____

b. _____

c. _____

d. _____

5. What can you do to prevent the engine from starting while it's cranking?

a. Remove the _____ from the _____, and ground it.

OR

b. Remove the _____ from the _____, but don't ground it.

6. If you don't want an electrical lead to become grounded, how can you protect it?

_____

7. What two instruments can be used to perform a continuity check?

a. _____

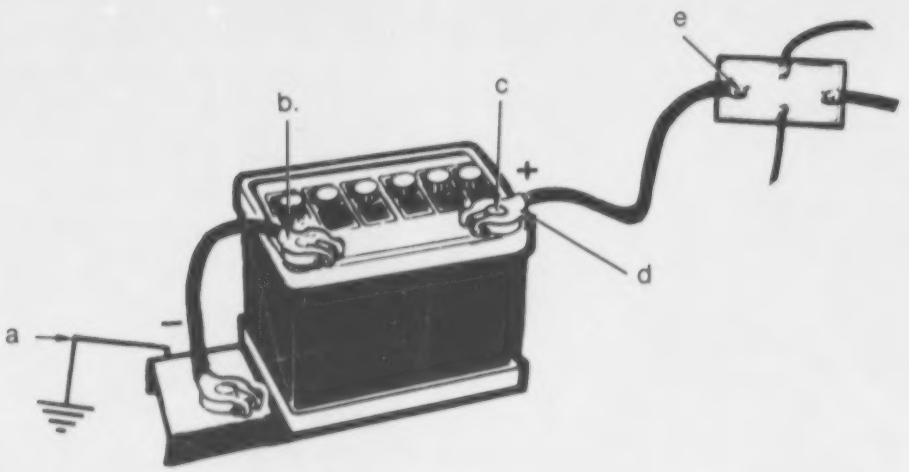
OR

b. _____

8. When testing continuity with an electric circuit tester, clip the negative lead to _____ _____, and place the tip of the circuit tester at the _____.

9. When testing continuity with a voltmeter, place the negative lead of the voltmeter at _____, and place the positive lead of the voltmeter at _____ _____.

Use the diagram below to complete questions 10-13, which are about the continuity test.



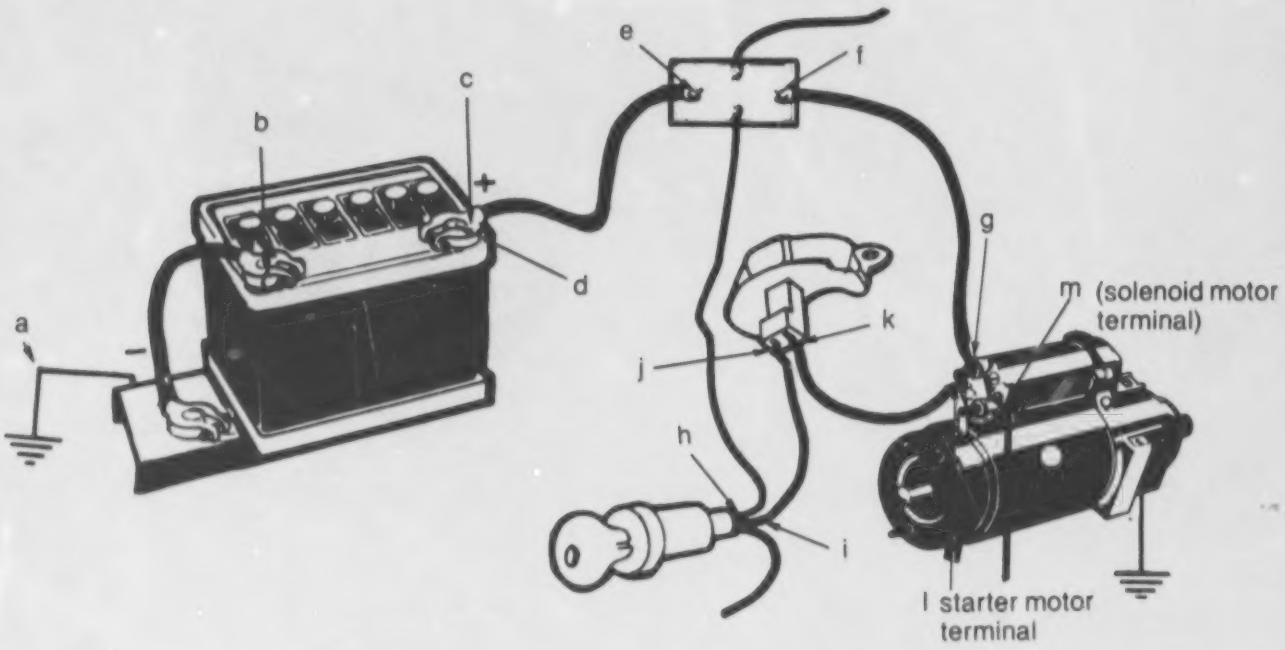
10. To check the circuit between the two battery terminals, put the positive lead at _____ and the negative lead at _____.

11. To check the circuit between the battery and ground, put the positive lead at _____ and the negative lead at _____.

12. To check the circuit between the insulated battery clamp and ground, put the positive lead at _____ and leave the negative lead at _____.

13. To check the circuit between the insulated cable clamp and the junction block, put the positive lead at _____ and leave the negative lead at _____.

Use the diagram below to answer questions 14-17, which are about the continuity test.



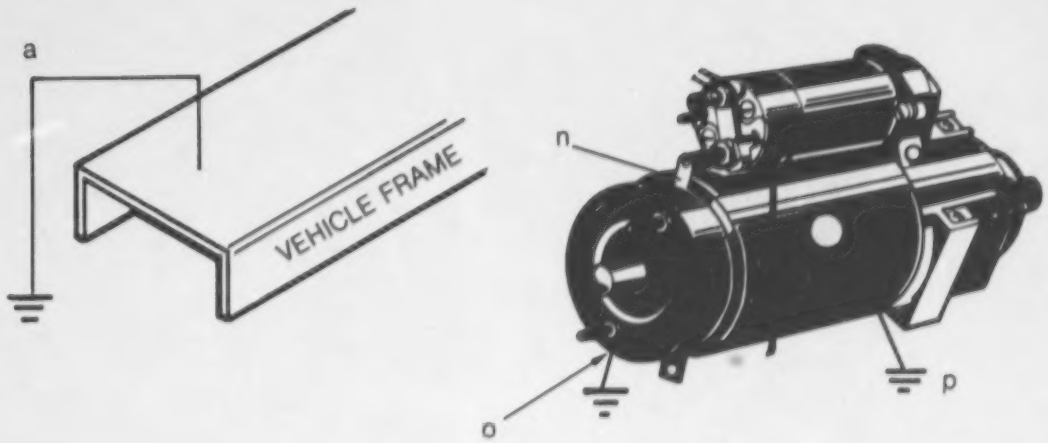
14. To check the circuit from the battery side of the junction block to the solenoid side of the junction block, place the positive lead at _____ and the negative lead at _____ .

15. To check the circuit between the junction block and the solenoid, put the positive lead at _____ and leave the negative lead at _____ .

16. To check the circuit between the junction block and the ignition switch, put the positive lead at _____ and the negative lead at _____ .

17. The next five test points are _____ , _____ , _____ , _____ , and _____ . To test these points, put the positive lead at _____ and leave the negative lead at _____ .

Use the diagram below to answer questions 18-20, which are about the continuity test.



18. To check the circuit between the solenoid and the cranking motor, put the positive lead at _____ and the negative lead at _____ .

19. To check the circuit between the solenoid and the engine block, leave the positive lead at _____ and put the negative lead at _____ .

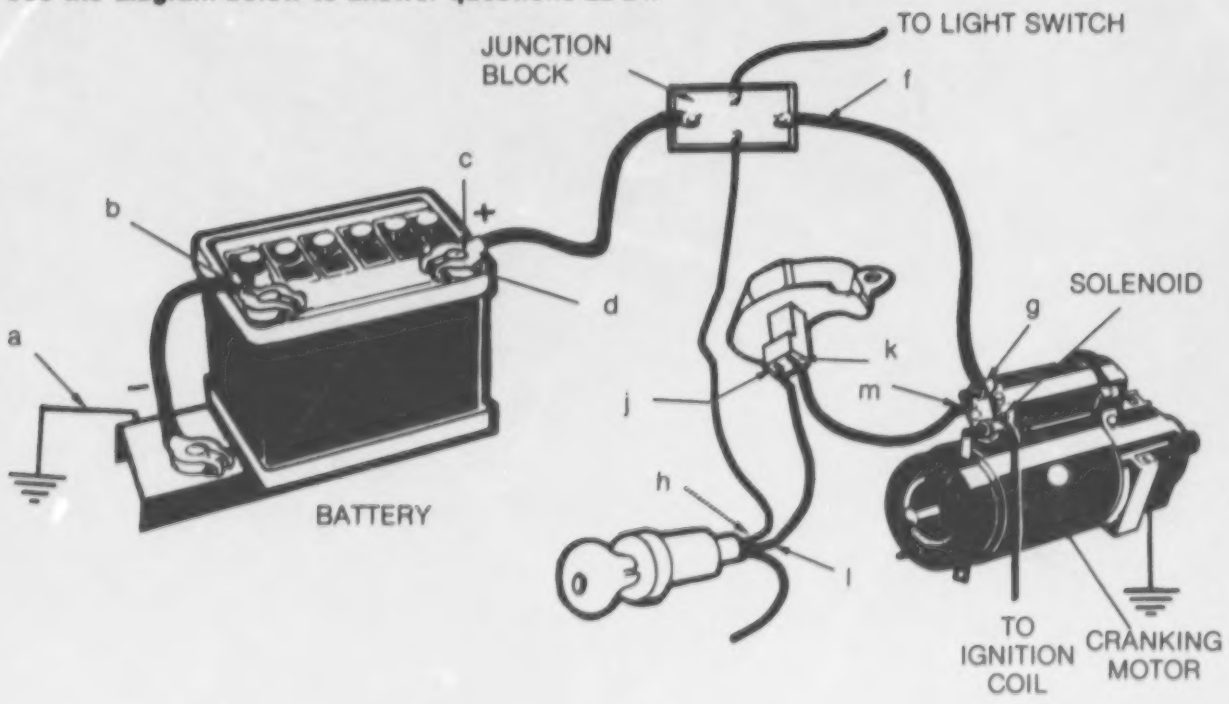
20. To check the circuit between the solenoid and ground at the vehicle frame, leave the positive lead at _____ and put the negative lead at _____ .

21. When should the engine be cranked during the continuity test?

_____

_____ .

Use the diagram below to answer questions 22-24.



22. If there is no power between any two points, you should check the _____ at each point to be sure they're clean and secure.

23. If there is no power between points *c* and *b*, what else should you do?

_____

_____

_____

24. If there is no power between two points in the circuit, and the leads and connections are in good condition, the component closest to the test point could be defective. For example, if there is no power between points ***k*** and ***a,*** and the connections are good, then the _____ _____ is probably defective.

25. Complete the statements below to describe the safety practices you must follow before cranking the engine.

    a. Disable the _____ .

    b. For all vehicles, engage the _____ .

    c. For automatic transmissions, place the vehicle in _____ .

    d. For a manual transmission with a neutral or clutch start switch, have someone press down on the _____ for you and _____ the engine.

    e. For a manual transmission without a neutral or clutch start switch, put the vehicle in _____ .

Now turn to the back of this book and check your answers for Exercise 10.

EXERCISE 11

1. You are working on a vehicle with an automatic transmission. What safety steps should you take before beginning the starter draw test? (Place a check mark beside all of the correct answers.)

   _____ a. Remove the center cable from the distributor cap and ground it.
   _____ b. Remove the battery lead from the ignition coil, but don't ground it.
   _____ c. Set the emergency brake.
   _____ d. Place the automatic transmission in low gear after cranking the engine.
   _____ e. Place the automatic transmission in park, and have someone else crank the engine for you.
   _____ f. Depress the neutral clutch start switch, and have someone else crank the engine for you.

2. What equipment do you use to do the starter draw test?

   _____ a. ammeter
   _____ b. voltmeter
   _____ c. battery starter tester
   _____ d. all of the above
   _____ e. none of the above

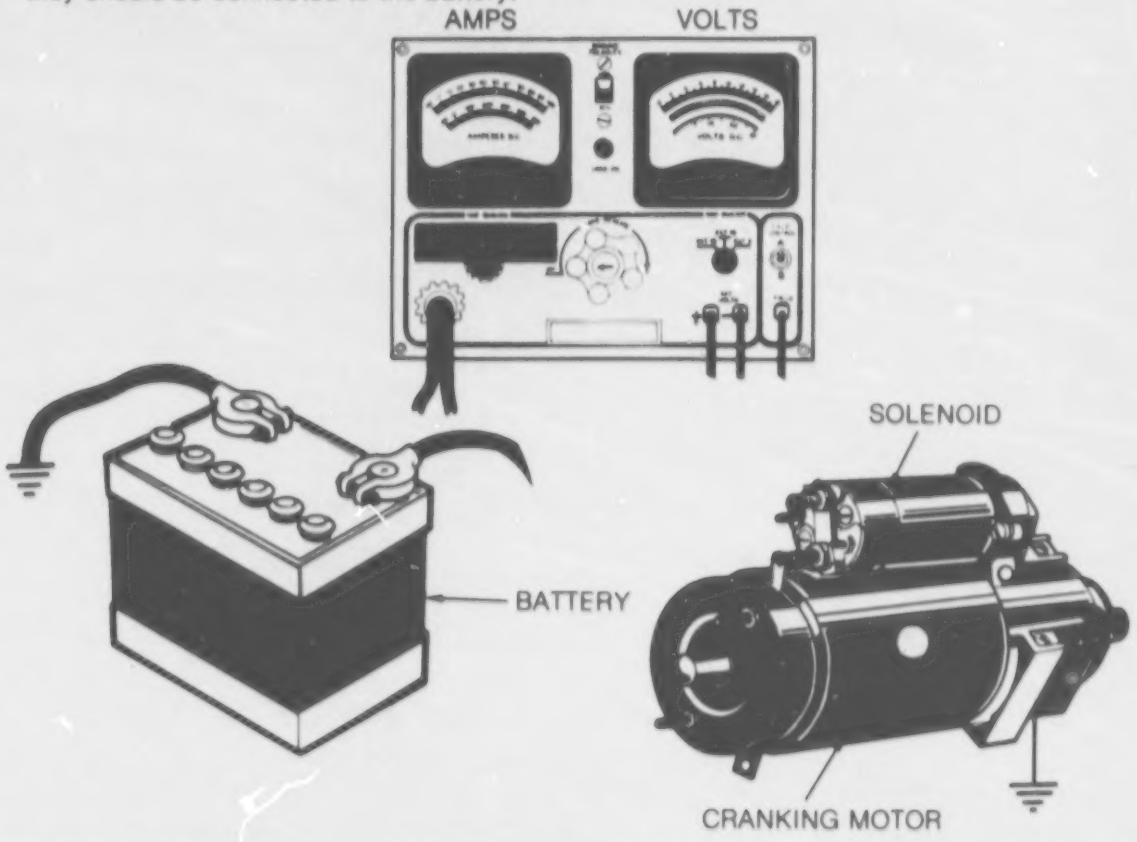
3. The purpose of the starter draw test is to find:

   _____ a. how many volts are used when the engine is operating
   _____ b. how much amperage is being used by the cranking motor when the engine is cranking
   _____ c. the capacity of the battery under a high load
   _____ d. how much carbon pile to add before getting the right amperage reading

4. For each statement below, assume that the motor speed is slow. Write *T* (for true) or *F* (for false) in the blank.

   _____ a. If the amperage that is drawn is too high, you'll need to do the voltage drop test.
   _____ b. If the amperage that is drawn is too low, the battery may be weak.
   _____ c. If the amperage that is drawn is too low, the battery may need to be checked.

5. Show how to connect the starter tester by drawing the ammeter leads and voltmeter leads as they should be connected to the battery.



6. Put the steps for doing the starter draw test in order by placing a *1* next to the first step, a *2* next to the second step, and so on.

_____ a. Read the voltage while the engine is cranking.
_____ b. Remove the load and disconnect the starter leads.
_____ c. Turn the load control knob until the voltage reads the same as it did when the engine was cranking.
_____ d. Connect the starter leads.
_____ e. Read the amperage.
_____ f. Have someone crank the engine for you.
_____ g. Signal your partner to stop cranking the engine.

Use these standard amperage draw rates to answer questions 7-9.

250 amps (for a large GMC 8-cylinder engine—400 cubic inches or more)

200 amps (for all other 8-cylinder engines)

180 amps (for all 6-cylinder engines)

7. The amperage drawn for a 1971 Buick 6-cylinder engine was 200 amps. This amperage draw is:

   _____ a. too low
   _____ b. too high

8. The amperage drawn for a 1975 Mercury V-8 with a 170-cubic-inch engine was 210 amps. This amperage draw is:

   _____ a. too low
   _____ b. too high

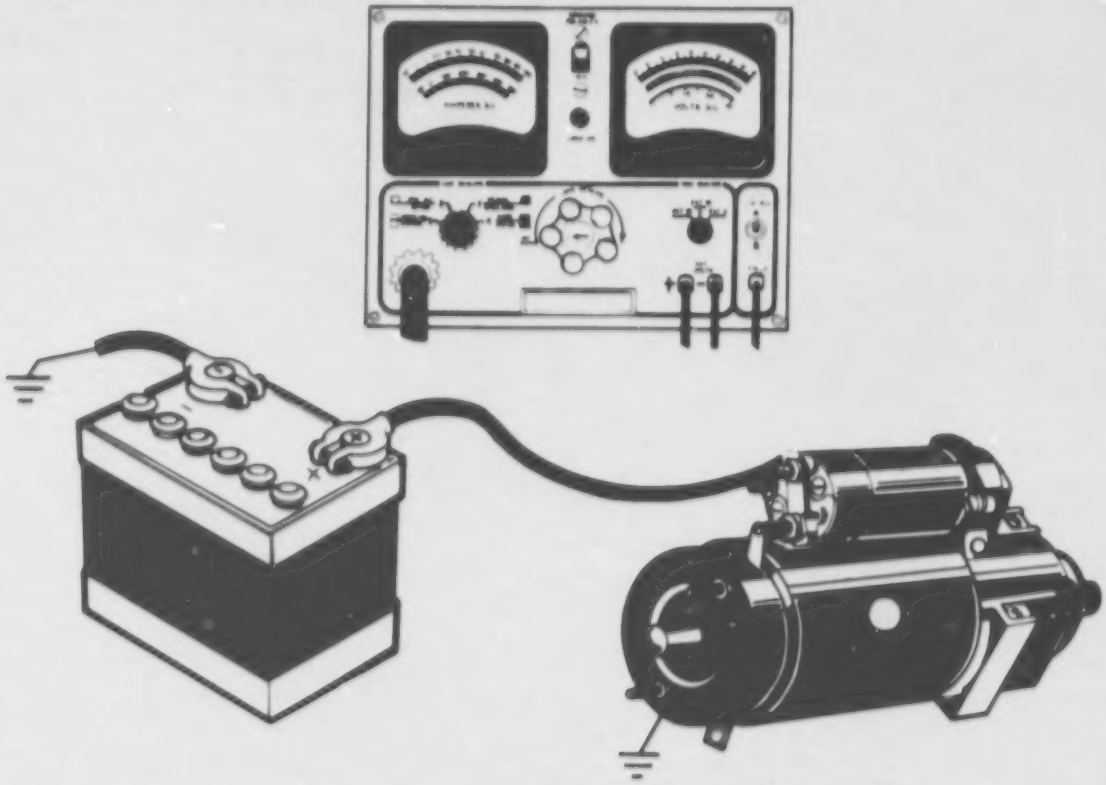
9. The amperage drawn for a 1974 Ford V-8 with a 460-cubic-inch engine was 190 amps. This amperage draw is:

   _____ a. too low
   _____ b. too high

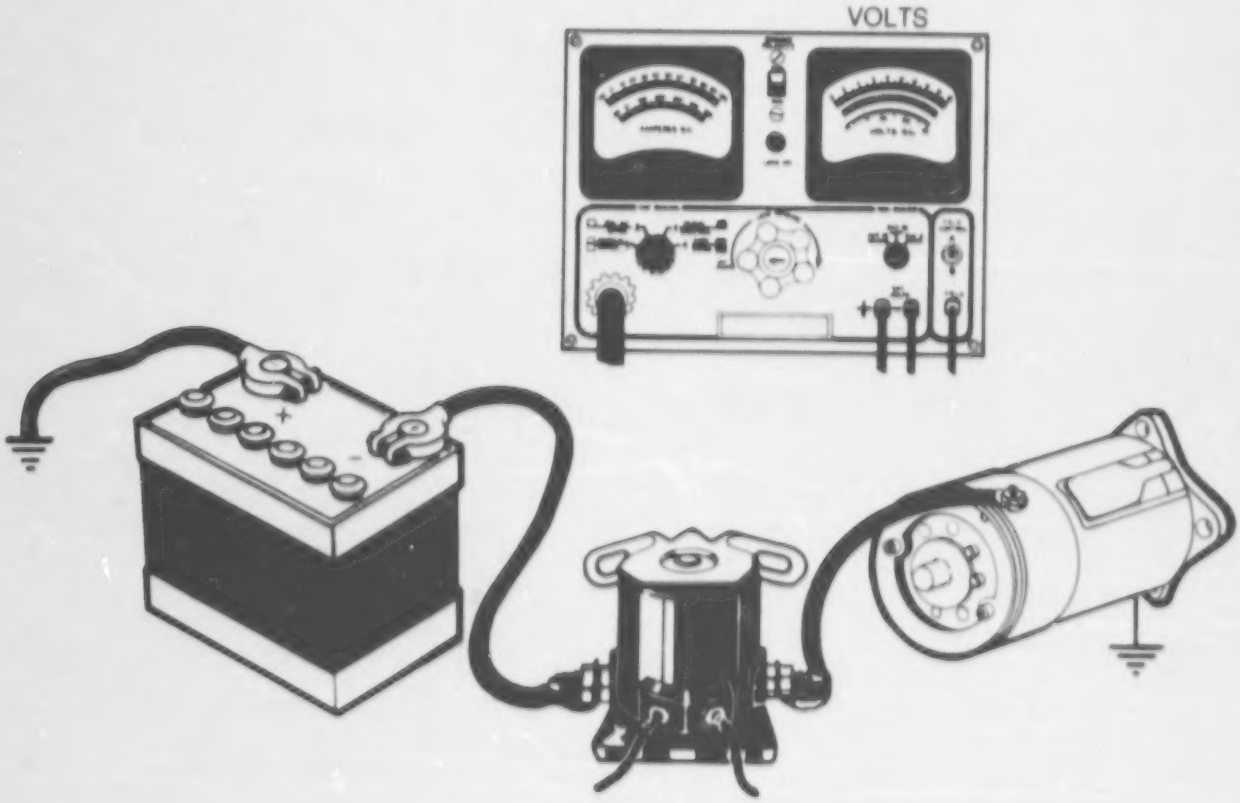
Now turn to the back of this book and check your answers for Exercise 11.

EXERCISE 12

1. If the voltage drop is high, resistance is _____ .
2. If the voltage drop is low, resistance is _____ .
3. When testing for voltage drop, _____ the ignition before cranking the engine.
4. When testing for voltage drop, engage the _____ before cranking the engine.
5. Draw the positive and negative leads to show how to check for voltage between the positive battery terminal post and the solenoid motor terminal.



6. Draw the positive and negative leads to show how to check for voltage drop between the positive battery terminal post and the motor terminal on the cranking motor.



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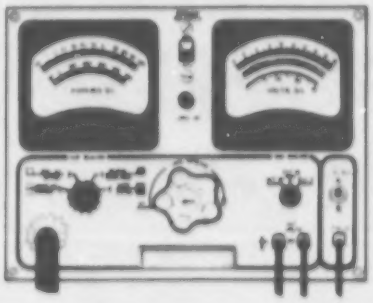
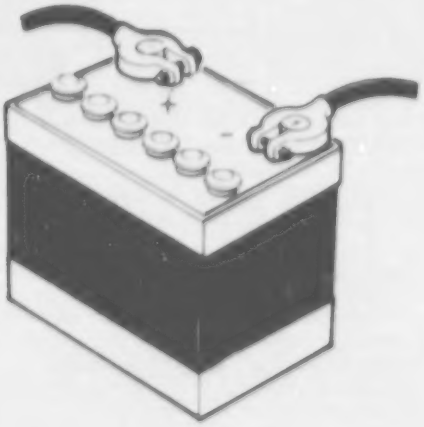
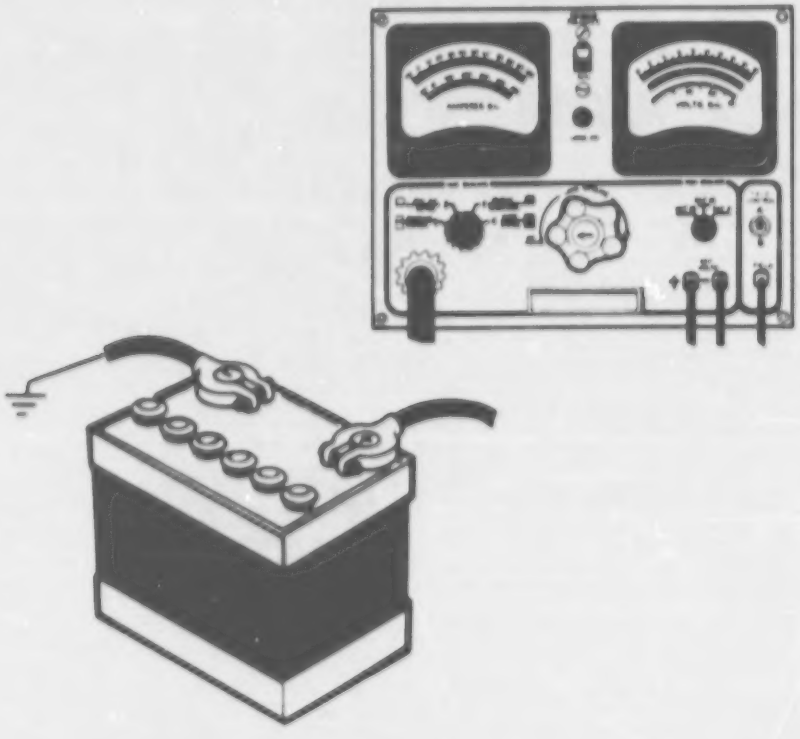
7. Draw the positive and negative leads to show how to check for voltage drop between the positive battery terminal post and the positive battery cable clamp.

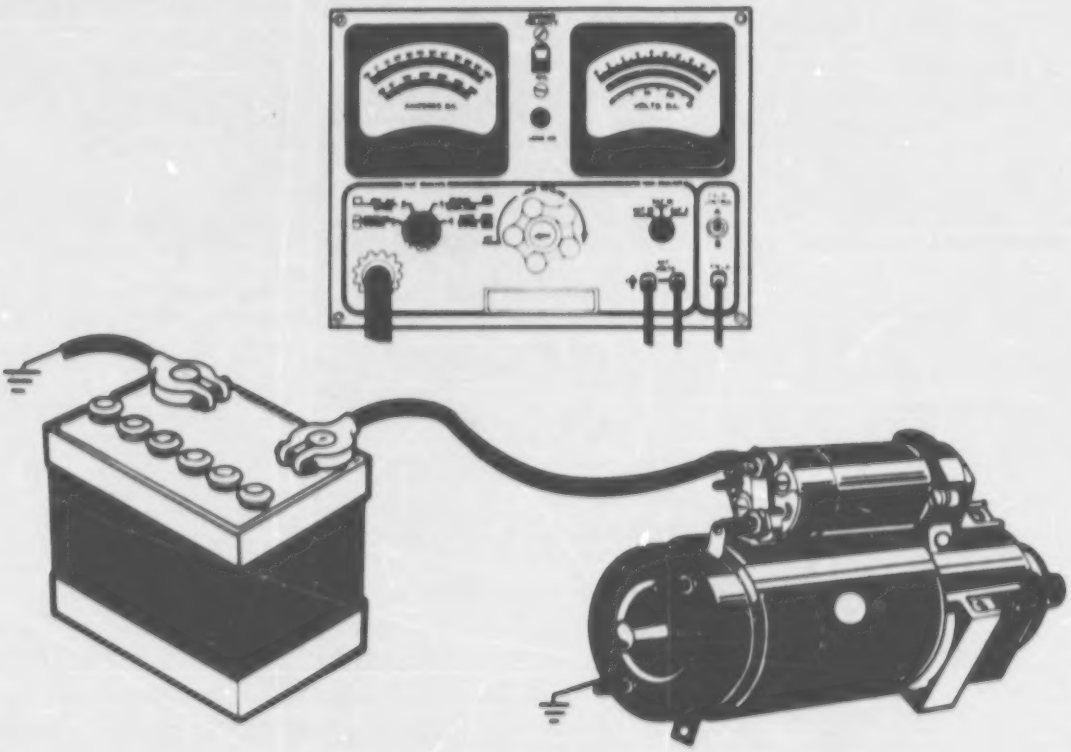




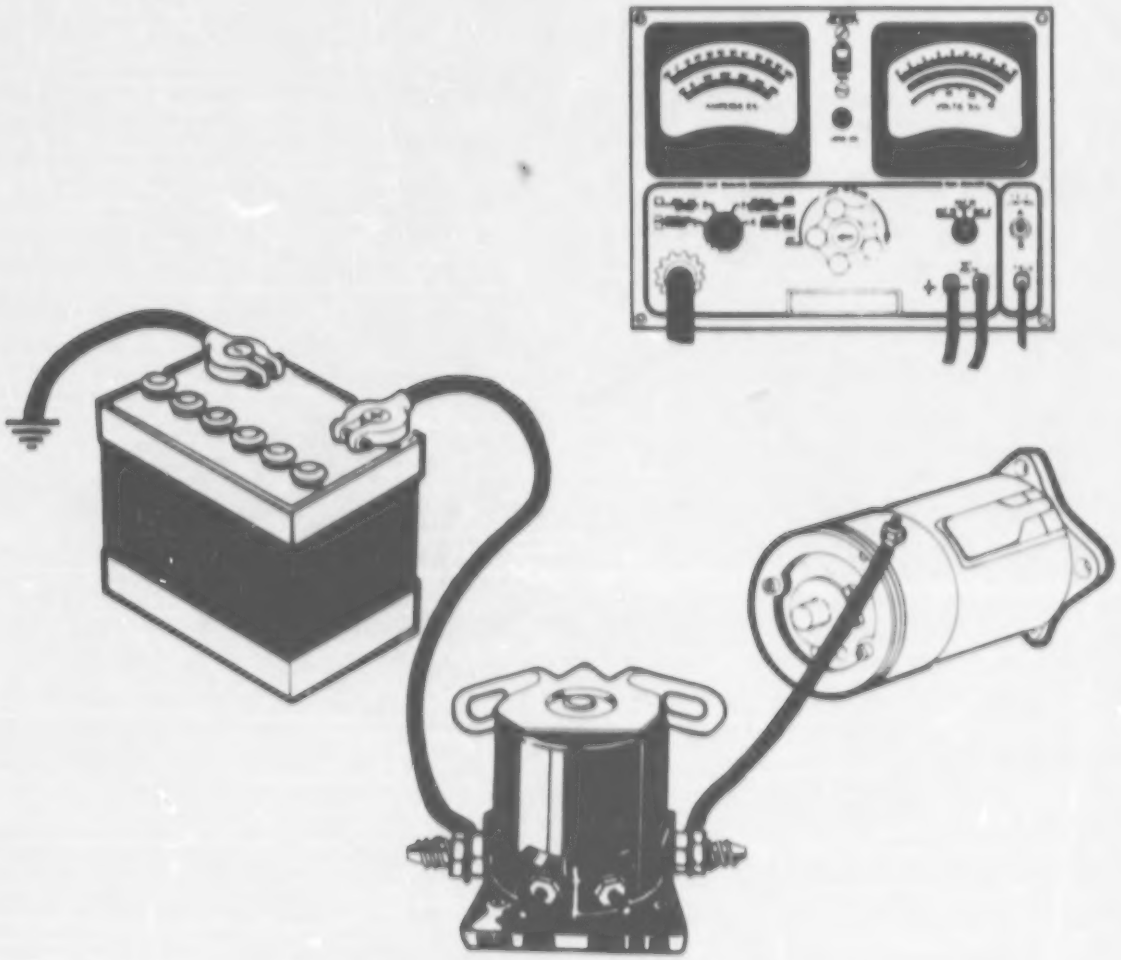
8. Draw the positive and negative leads to show how to check for voltage drop between the negative battery cable clamp and the negative battery terminal post.



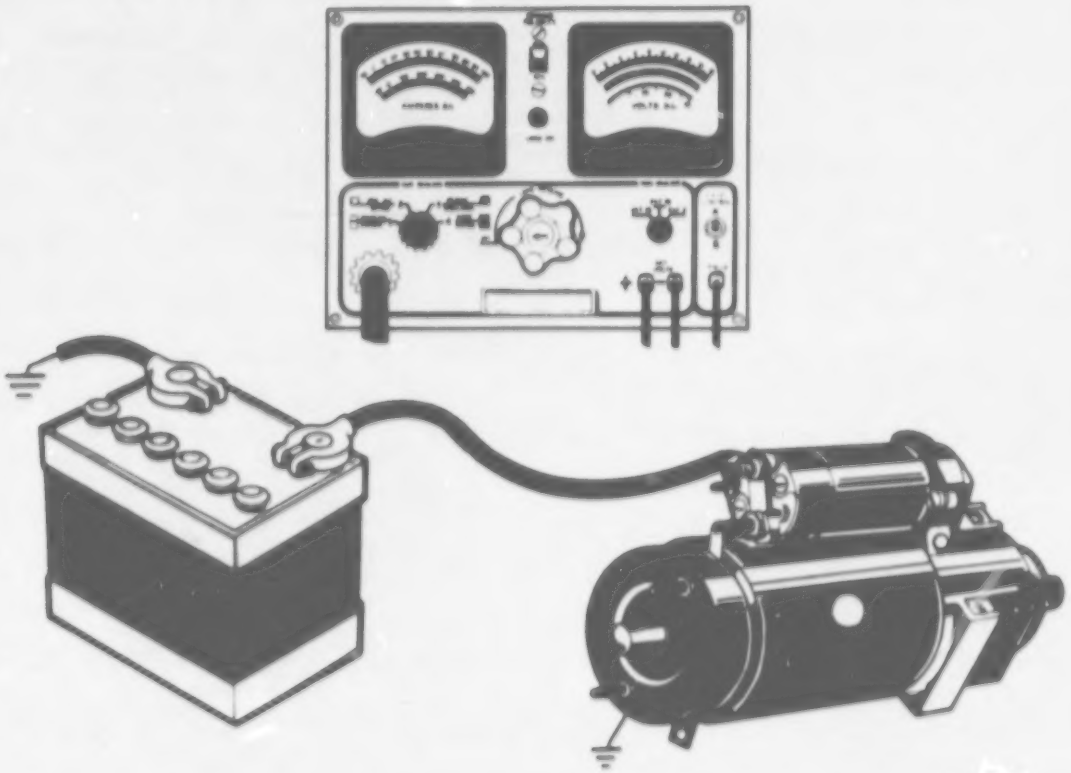
9. Draw the positive and negative leads to show how to check for voltage drop between the positive battery cable clamp and the solenoid battery terminal.



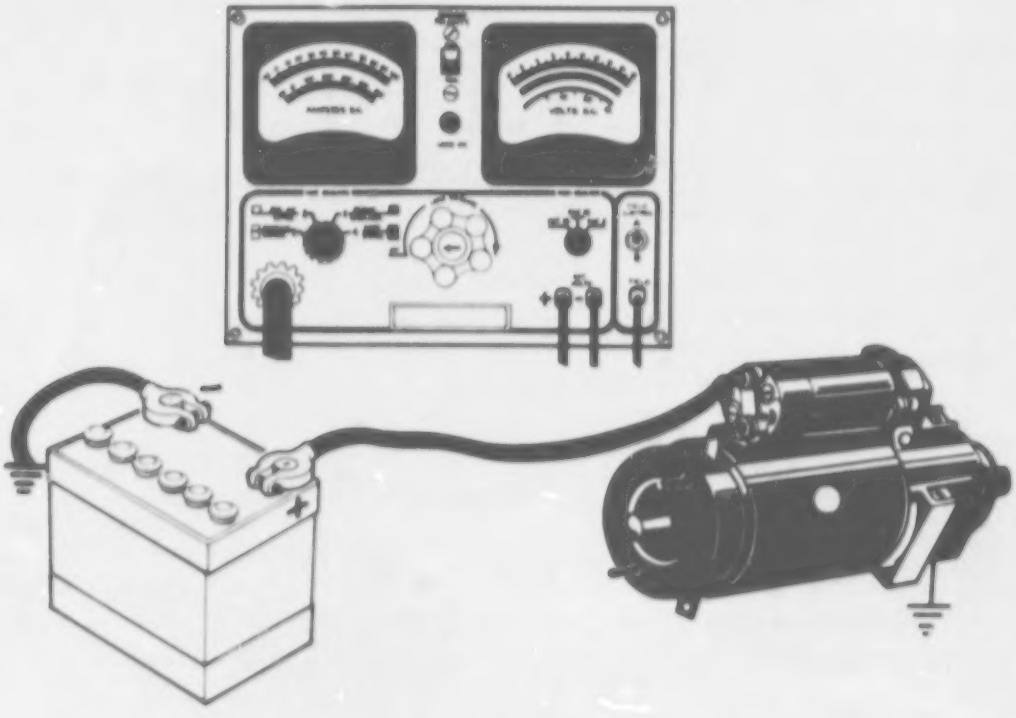
10. Draw the positive and negative leads to show how to check for voltage drop between the positive battery cable clamp and the battery terminal on the starter relay.



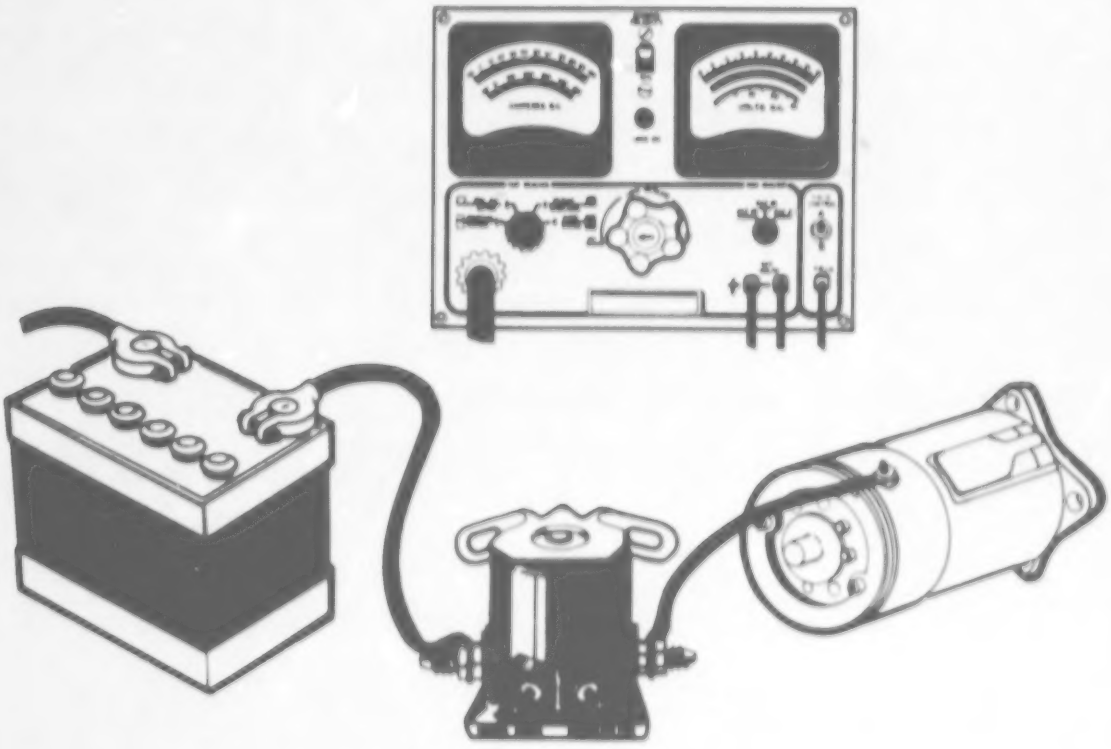
11. Draw the positive and negative leads to show how to check for voltage drop between the solenoid battery terminal and the solenoid motor terminal.



12. Draw the positive and negative leads to show how to check for voltage drop between the battery terminal on the starter relay and the motor terminal on the starter relay.



13. Draw the positive and negative leads to show how to check for voltage drop between the negative battery cable clamp and ground.



For questions 14-22, you'll be given a description of the place to check for voltage drop and the maximum reading that you should find there. The maximum reading is the highest reading the circuit could have before it lost too much voltage.

14. Place to Check — Maximum Reading

Between the positive battery terminal post and the solenoid terminal. (Refer to question 5.) — 0.5 volt

The voltage drop is 0.6 volt. What should you do next? _____

_____

Why? _____

15. Place to Check — Maximum Reading

Between the positive battery terminal post and the motor terminal on the cranking motor. (Refer to question 6.) — 0.5 volt

The voltage drop is 0.5 volt. What should you do next? _____

_____

Why? _____

16. Place to Check — Maximum Reading

Between the positive terminal post and the positive battery cable clamp. (Refer to question 7.) — 0.0 volts

The voltage drop is 0.1 volt. What should you do next? _____

_____

Why? _____

17. Place to Check — Maximum Reading

Between the negative battery cable clamp and the negative battery terminal post. (Refer to question 8.) — 0.0 volts

The voltage drop is 0.0 volts. What should you do next? _____

_____

Why? _____

18. Place to Check — Maximum Reading

Between the positive battery cable clamp and the solenoid battery terminal. (Refer to question 9.) — 0.2 volt

The voltage drop is 0.2 volt. What should you do next? _____

_____

Why? _____

19. Place to Check — Maximum Reading

Between the positive battery cable clamp and the battery terminal on the starter relay. (Refer to question 10.) — 0.2 volt

The voltage drop is 0.4 volt. What should you do next? _____

_____

Why? _____

20. Place to Check — Maximum Reading

Between the solenoid battery terminal and the solenoid motor terminal. (Refer to question 11.) — 0.3 volt

The voltage drop is 0.2 volt. What should you do next? _____

_____

Why? _____

21. Place to Check — Maximum Reading

Between the battery terminal on the starter relay and the motor terminal on the starter relay. (Refer to question 12.) — 0.3 volt

The voltage drop is 0.2 volt. What should you do next? _____

_____

Why? _____

22. Place to Check — Maximum Reading

Between the negative battery cable clamp and ground. (Refer to question 13.) — 0.1 volt

The voltage drop is 0.2 volt. What should you do next? _____

_____

Why? _____

Now turn to the back of this book and check your answers for Exercise 12.

PERFORMANCE CHECKLIST—P.O. 2

The instructor will provide a vehicle with a cranking circuit malfunction. All necessary tools, equipment, and manuals must be made available.

Student Performances

1. Visually inspects battery case, cables, clamps, and all other cables and connections; takes appropriate action.
2. Performs battery capacity test and takes appropriate action.
3. Performs continuity check as needed.
4. Performs starter draw test as needed.
5. Performs voltage drop test as needed.
6. Reports any malfunctions in cranking system.
7. Uses appropriate tools and equipment.
8. Follows all safety precautions.
9. Time.

Instructor Ratings

Acceptable	Not Acceptable	Omit

Keep this checklist for your records.

P.O. 3 PRETEST

NAME _____

1. Place a check mark beside all of the safety practices listed below that you should follow when using floor jacks and jack stands.

   _____ a. Leave the jack handle neatly stored while the jack is in use.
   _____ b. Check the vehicle for stability by rocking it back and forth after the jack stands are in place.
   _____ c. Never raise a vehicle quickly with a floor jack.
   _____ d. The jack should contact the vehicle at the bumper.
   _____ e. Use the jack stands to support the vehicle after lifting.
   _____ f. Leave the jack handle lying neatly on the floor while the jack is in use.

2. Place a check mark beside all of the safety practices listed below that you should follow when using hydraulic lift equipment.

   _____ a. Check to be sure that the vehicle is secure on the lift by rocking it back and forth.
   _____ b. The lift capacity can be exceeded when necessary by as much as 25 percent.
   _____ c. Always set the safety lock on lift equipment after raising the vehicle.
   _____ d. Check to be sure that the vehicle is secure on the lift after raising it about two feet.
   _____ e. Compare the lift's rated capacity with the vehicle weight before raising.

3. Place a check mark beside all of the safety practices listed below that you should follow.

   _____ a. Use caution when lifting heavy starters.
   _____ b. Wear all your jewelry on one arm only.
   _____ c. Be sure that your clothing is very loose to allow for easy movement.
   _____ d. Avoid making electrical tests in wet areas.
   _____ e. Always wear eye protection when working beneath a vehicle.
   _____ f. Use your memory for correct test equipment procedures.

4. The steps listed below for installing a starter are out of order. Write the letter of each step in the blank beside the proper number to show the correct sequence.

Order	Steps
_____ 1.	a. Reconnect the wires and cables to the starter.
_____ 2.	b. Position the starter and replace the mounting bolts and brackets.
_____ 3.	d. Reconnect the battery ground cable clamp.
_____ 4.	e. Replace the heat shield as necessary.

5. The steps listed below for removing a starter with a solenoid from a car with a heat shield are out of order. Write the letter of each step in the blank beside the proper number to show the correct sequence.

Order	Steps
_____ 1.	a. Lift out the starter.
_____ 2.	b. Remove the starter brackets.
_____ 3.	c. Remove the heat shields.
_____ 4.	d. Remove the starter mounting bolts.
_____ 5.	e. Remove the ground cable clamp from the battery.
_____ 6.	f. Remove the cables and wires from the starter.
_____ 7.	g. Raise the vehicle as necessary.

6. Place a check mark beside the ***two*** ways of inspecting the flywheel ring gear.

_____ a. Gently pry at the ring gear with a pry bar.
_____ b. Check the engine RPM at cranking speed.
_____ c. Place an electrical load on the ring gear.
_____ d. Visually check the ring gear.
_____ e. Crank the engine and watch the flywheel revolve.

7. Place a check mark beside the ***two*** recommended ways to test a starter after installation.

_____ a. battery capacity test
_____ b. starter draw test
_____ c. voltage drop test
_____ d. operational check
_____ e. continuity test

8. When removing a starter, you should store the terminal nuts:

_____ a. in a plastic bag
_____ b. with the cranking motor
_____ c. in your pocket
_____ d. on the terminals
_____ e. by taping them to the chassis

9. When removing a starter, you will sometimes need to use:

_____ a. a ratchet wrench
_____ b. a torque wrench
_____ c. a crescent wrench
_____ d. an ignition wrench
_____ e. a half-moon wrench
_____ f. a left-handed monkey wrench

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 13

1. Statements *a* through *g* below deal with personal and service safety practices. Complete each statement.
   a. Never put more _____ on hydraulic floor jacks, jack stands, or lifts than their _____.
   b. Place the jack securely under the vehicle _____.
   c. _____ raise the vehicle with the jack.
   d. Always support the vehicle with the _____ placed securely under the vehicle.
   e. Always place the jack handle in the _____ position. Don't leave it on the _____ where a person can _____ over it.
   f. Never _____ the vehicle in any direction while it is on the lift.
   g. Always be sure the vehicle is _____ on the lift before raising it up high. Raise the lift _____ off the floor and check that the vehicle is still secure before raising it higher.
2. Why shouldn't you wear metal jewelry while you make electrical tests?

   _____
3. Why shouldn't you wear loose-fitting clothing or have long hair hang loosely while you're working around an operating engine?

   _____
4. Why should you wear eye protection when you're working under a vehicle?

   _____
5. In the blanks below, write *T* (for true) or *F* (for false).
   _____ a. You should follow the vehicle manufacturer's procedures for removing the cranking motor.
   _____ b. The cranking motor is the same as the starter.
   _____ c. The starter is heavy and should be removed carefully.

6. Which is the best order to follow when removing the cranking motor?

_____ a. (1) Remove the battery ground cable.
(2) Lift the vehicle as necessary.
(3) Remove the brackets on the cranking motor.
(4) Remove the mounting bolts.
(5) Remove the heat shield as necessary.
(6) Remove the cables and wires.
(7) Pull out the cranking motor.

_____ b. (1) Lift the vehicle as necessary.
(2) Remove the brackets on the cranking motor.
(3) Remove the heat shield as necessary.
(4) Remove the mounting bolts.
(5) Remove the battery ground cable.
(6) Remove the cables and wires.
(7) Pull out the cranking motor.

_____ c. (1) Remove the battery ground cable.
(2) Lift the vehicle as necessary.
(3) Remove the heat shield as necessary.
(4) Remove the cables and wires.
(5) Remove the mounting bolts.
(6) Remove the brackets on the cranking motor.
(7) Pull out the cranking motor.

7. What should you do with the nuts and bolts that you remove from the cranking motor cables and wires? _____

8. In the blanks below, write a *T* (for true) or *F* (for false).

_____ a. When doing a tune-up, you may need to replace the flywheel ring gear.

_____ b. When doing a tune-up, you may need to report a loose flywheel ring gear or worn-down spots on the ring gear.

Now turn to the back of this book and check your answers for Exercise 13.

100

EXERCISE 14

1. Which is the best order to follow when installing the cranking motor?

   _____ a. (1) Reconnect the wires and cables to the cranking motor.
   (2) Replace the heat shield as necessary.
   (3) Reconnect the battery ground cable.
   (4) Position the cranking motor and replace the bolts and/or brackets.

   _____ b. (1) Reconnect the battery ground cable.
   (2) Replace the heat shield as necessary.
   (3) Position the cranking motor and replace the bolts and/or brackets.
   (4) Reconnect the wires and cables to the cranking motor.

   _____ c. (1) Reconnect the wires and cables from the cranking motor to the correct terminals by using nuts and bolts.
   (2) Position the cranking motor and replace the bolts and/or brackets.
   (3) Replace the heat shield as necessary.
   (4) Reconnect the battery ground cable.

2. In the blanks below, write *T* (for true) or *F* (for false).

   _____ a. The starter draw test tells you how much amperage the cranking motor is drawing when the engine is cranking.
   _____ b. The starter draw test is done after the cranking motor is installed.
   _____ c. Before you do the starter draw test, you should crank the engine to check the operation of the cranking motor.

Now turn to the back of this book and check your answers for Exercise 14.

PERFORMANCE CHECKLIST—P.O. 3

The instructor will provide a vehicle on which the student can replace the starter. All necessary tools, equipment, and manuals must be made available.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Removes negative clamp from the battery terminal.			
2. Raises vehicle as necessary.			
3. Disconnects wires from the starter and/or solenoid and marks for reinstallation.			
4. Removes starter mounting bolts and lifts out starter.			
5. Installs new starter, attaching wires first as necessary.			
6. Lowers vehicle as necessary.			
7. Reconnects negative clamp to the battery terminal.			
8. Performs an operational check.			
9. Conducts the starter draw test as necessary.			
10. Uses appropriate tools and equipment.			
11. Follows all appropriate safety precautions.			
12. Time.			

Keep this checklist for your records.

P.O. 4 PRETEST

NAME _____

1. The steps listed below, for removing a solenoid from a starter with an overrunning clutch drive, are out of order. Write the letter of each step in the blank beside the proper number to show the correct sequence.

Order	Steps
_____ 1.	a. Remove the starter and solenoid unit.
_____ 2.	b. Twist the solenoid about a quarter turn to one side.
_____ 3.	c. Remove the solenoid, being careful not to lose the return spring.
_____ 4.	d. Remove the solenoid mounting screws.
_____ 5.	e. Remove the contact nut or screw.

2. The steps listed below for replacing a solenoid are out of order. Write the letter of each step in the blank beside the proper number to show the correct sequence.

Order	Steps
_____ 1.	a. Test the solenoid operation.
_____ 2.	b. Properly position the solenoid.
_____ 3.	c. Replace the mounting screws.
_____ 4.	d. Replace the contact nut or screw.
_____ 5.	e. Seal the solenoid-to-starter surface.
_____ 6.	f. Install the solenoid and cranking motor.

3. A defective solenoid is usually:

   _____ a. replaced
   _____ b. repaired

4. When removing a remote starter relay switch, is the starter removed?

   _____ a. yes
   _____ b. no

5. Place a check mark beside the *two* cranking circuit tests that can tell you whether a solenoid is defective.

   _____ a. continuity test
   _____ b. operational check
   _____ c. voltage drop test
   _____ d. starter draw test
   _____ e. battery capacity test

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 15

1. In the blanks below, write *T* (for true) or *F* (for false).

   _____ a. A defective starter solenoid is usually overhauled or repaired.

   _____ b. If the voltage drop between the battery terminal and motor terminal on the starter solenoid is too high (for example, more than 0.3 v), the starter solenoid needs to be replaced.

2. Complete these statements of the basic steps for removing the starter solenoid.

   a. Remove the _____ and the starter solenoid unit.

   b. Remove the _____ or _____ that connects the starter solenoid to the cranking motor.

   c. Remove the _____ from the starter solenoid.

   d. Twist the starter solenoid about _____ of the way to one side.

   e. Disconnect the starter solenoid from the _____ . Be careful not to lose the _____ inside it.

3. Complete these statements of the basic steps for installing the starter solenoid.

   a. Place the starter solenoid in position on top of the _____ _____ .

      Be sure the _____ is also in position.

   b. Replace the _____ or _____ .

   c. _____ the surface where the starter solenoid fits next to the _____ .

   d. Replace the _____ .

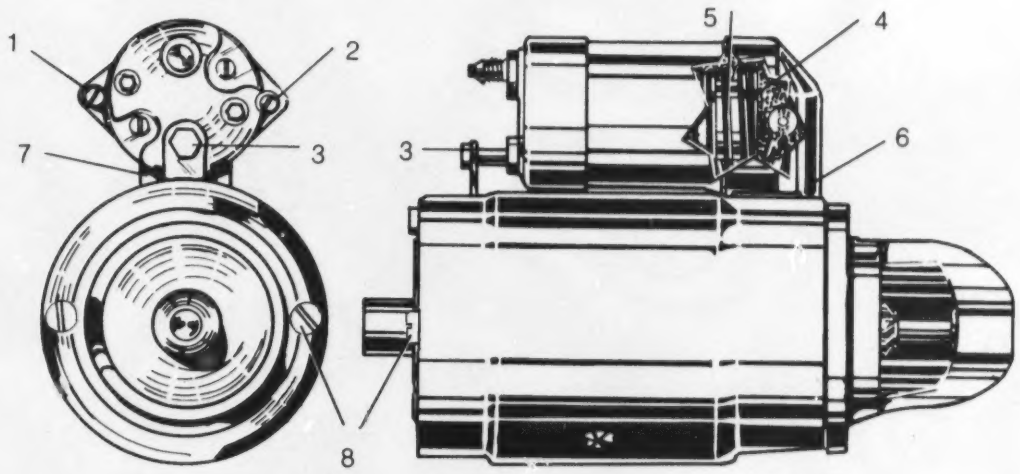
   e. _____ the starter solenoid and cranking motor unit.

   f. Test the operation of the starter solenoid by _____ _____.

4. Identify each of the parts labeled in the diagram below by writing the letter of the correct part name in the proper blank. (You'll find some of these parts located in more than one place.)

_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.

a. mounting screw
b. contact nut or screw
c. return spring
d. seal
e. body screws



Now turn to the back of this book and check your answers for Exercise 15.

PERFORMANCE CHECKLIST—P.O. 4

The instructor will provide a vehicle on which the student can replace the solenoid. All necessary tools, equipment, and manuals must be made available.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Removes negative clamp from the battery terminal.			
2. Raises vehicle as necessary.			
3. Disconnects wires from the solenoid and marks for reinstallation.			
4. Removes solenoid and starter as necessary.			
5. Installs new solenoid.			
6. Attaches solenoid wires.			
7. Lowers vehicle as necessary.			
8. Reconnects negative clamp to the battery terminal.			
9. Performs an operational check.			
10. Conducts other tests as necessary to ensure proper operation.			
11. Uses appropriate tools and equipment.			
12. Follows all appropriate safety precautions.			
13. Time.			

Keep this checklist for your records.

ANSWERS TO THE EXERCISES

ANSWERS TO EXERCISE 1

1. a. ground (negative) cable
   b. battery
   c. insulated (positive) cable
   d. cranking motor (starter)
   e. solenoid
   f. neutral safety switch
   g. ignition switch
2. battery
3. battery cables, insulated, ground
4. cranking motor (starter)
5. neutral safety
6. pinion gear
7. c
8. a
9. volts
10. a
11. amperes
12. continuity tester
13. ampere
14. volt
15. d
16. b
17. resistance
18. b

Now turn to page 13 in your Student Guide.

ANSWERS TO EXERCISE 2

1. a. negative terminal post
   b. battery casing
   c. vent cap (cell cover)
   d. electrolyte (acid and water)
   e. battery cell(s)
   f. positive terminal post
   g. battery cable clamps
   h. battery cable
2. b
3. b
4. a
5. a
6. b
7. b
8. a
9. b
10. decreases
11. decreases
12. a. sulfuric acid
    b. water
13. 6 cells
14. a
15. about 2.5 volts
16. to let gases escape from the battery
17. a. lead
    b. sulfuric acid, water
    c. lead, sulfuric acid, power (voltage)
18. Rinse your skin with water or milk, or put baking soda on your skin.
19. Squirt your eyes directly with water, or wash your eyes with milk. Contact a doctor immediately.
20. a. goggles or other eye protection
    b. rubber gloves
    c. rubber apron

21. Rinse your hands with water

22. cover

23. A spark or flame may cause the battery to explode.

24. Jewelry can make contact with an electrical connection and give you a severe burn.

25. Loose work clothes can get caught in the moving parts of the engine.

26. Long, loose hair can get caught in moving parts of the engine.

27. The alternator can be damaged.

28. The battery won't work properly.

29.

a. 5	d. 4	g. 1	j. 8
b. 7	e. 9	h. 6	k. l
c. 6	f. 2	i. 3	

30. a. Fill the cells with water.
    b. Rinse the battery with water and let it dry.
    c. Replace the cable.
    d. Clean the battery and connecting parts.
    e. Replace the battery.
    f. Loosen the hold-down clamps.
    g. Replace the battery.
    h. Tighten the hold-down clamps.

31. a

32. It can cause a malfunction in the cranking system.

33. a. each vent cap
    b. look inside each cell opening
    c. split ring

34. a. battery filler
    b. split ring
    c. vent cap
    d. vent holes

35. electrolyte, water

36. a. Rinse the battery with water.
    b. Let the battery dry naturally.

37. An air hose could cause electrolyte to spray out and burn someone.

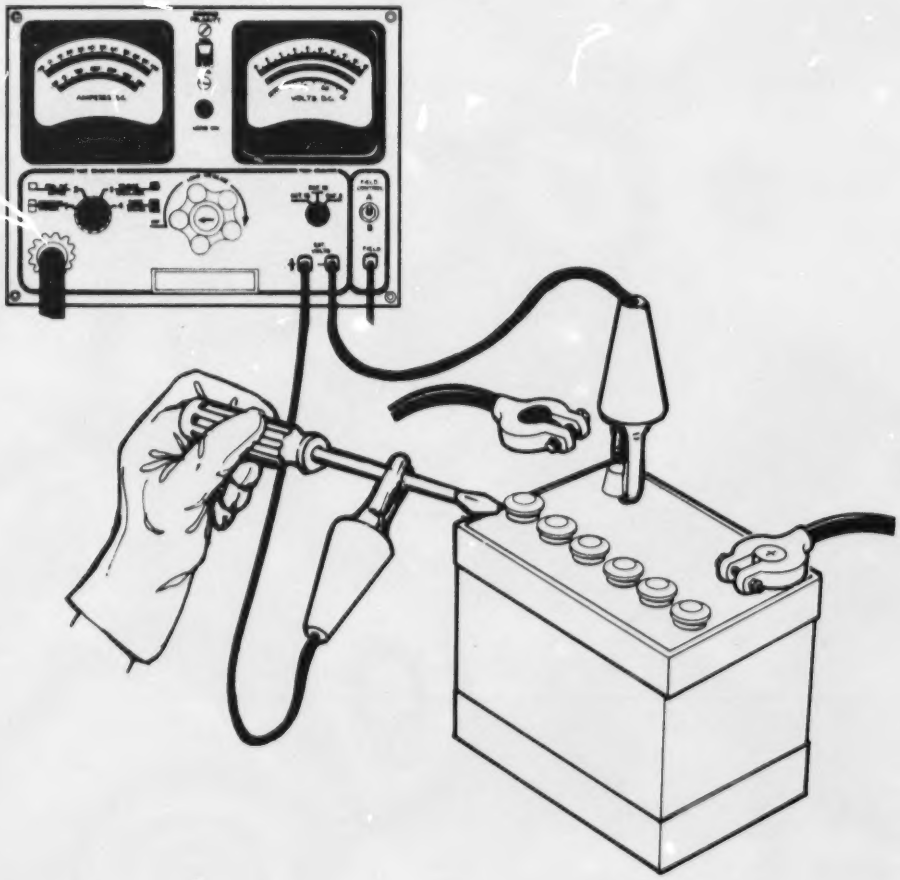
38. Acid left on the rags after you wipe the battery will eat holes in the rags or burn someone who picks them up.

39. Let it dry naturally.

Now turn to page 37 in your Student Guide.

ANSWERS TO EXERCISE 3

1.



2. positive

3. battery top

4. a. Reconnect the ground cable.
   b. Clean the battery.

5. ground

6. a

7. d

8. c

9. a

10. b

11. a battery case carrier or battery strap

12. a. Wear goggles or other eye protection.
    b. Don't light matches or cause any other sparks or flames near a battery.
    c. Battery service should be done in a well-ventilated area where there is access to water.
    d. Use the correct tool for each step in a work activity.
    e. Protect vehicle fenders with a cover.
    f. (1) Disconnect the ground cable first; reinstall it last.
       (2) Disconnect the insulated cable last; reinstall it first.

13. d

14. a. 1
    b. 2
    c. 3

15. bright

16. 2 tablespoonfuls, 2 cupfuls

17. a, b, c, d

18. b

19. a, b, c, d, e

20. b, d

21. The insulated cable should be reconnected.

22. defective

23. voltage, rating

24. a. yes
    b. Because everything else checks out and the battery is still leaking. It is defective.
    c. 80 amps
    d. 12-volt

25. a, c, d

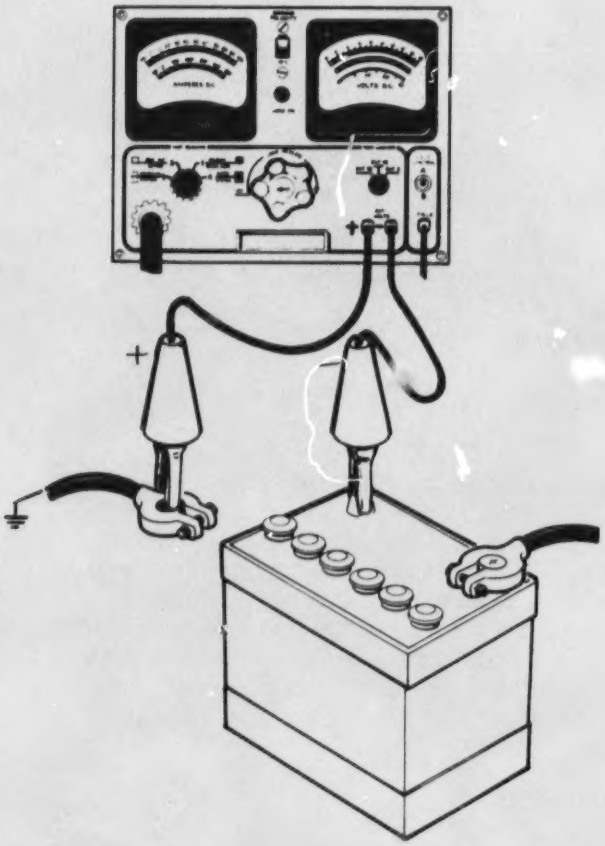
26. anticorrosion paste

27. a, b

Now turn to page 49 in your Student Guide.

ANSWERS TO EXERCISE 4

1. It could create a spark and ignite the battery gases.
2. voltmeter, volt-amp tester
3. when there is no battery drain
4. wiring
5. battery top
6.



7. a. Reconnect the alternator leads and the ground cable, and proceed with other tests.
   b. (1) Be sure that all electrical equipment is turned off.
   (2) Check the reading again.
   (3) Check with your instructor if there is still battery drain.

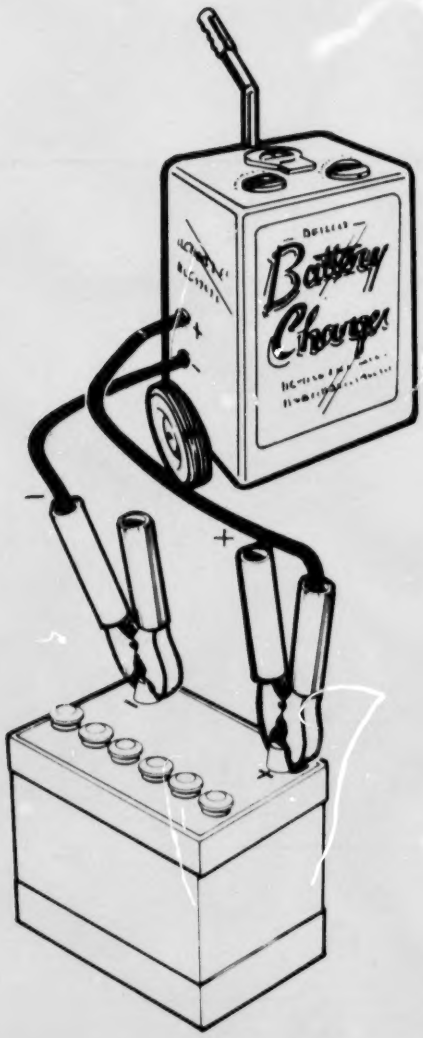
8. d (If there is no leakage across the battery top, any current drain must be in the electrical system.)
9. a. remove
   b. squeeze
   c. hydrometer tip
   d. release, float
   e. scale, eye
   f. above, squeeze
   g. b-f
10. Add .004 to the reading for each 10° F. above 80°. Subtract .004 from the reading for each 10° F. below 80°.
11. 1.224
12. 1.216
13. 1.218
14. 1.220
15. 1.214
16. 1.228
17. no
18. maybe
19. no
20. a. no
    b. yes

Now turn to page 55 in your Student Guide.

ANSWERS TO EXERCISE 5

1. a. Correct them before charging.
   b. Be sure the vent caps are on and the vent holes are open.
   c. The battery must be at room temperature before charging.
   d. Disconnect the ground cable first and the insulated cable last. Reconnect the insulated cable first and the ground cable last.
   e. Be sure it's turned to OFF before charging.
   f. Set up the battery and charging equipment in a well-ventilated area.
   g. Store batteries on a wood block or shelf—not on concrete.
   h. Set up charging in an area where water is available.
   i. Follow instructions for connecting the charging equipment.
2. a. Don't let it go over 125° F.
   b. Don't let it go over 1.270.
   c. Don't let it go over 15.5 volts.
   d. Follow the equipment manufacturer's instructions.
3. a
4. a

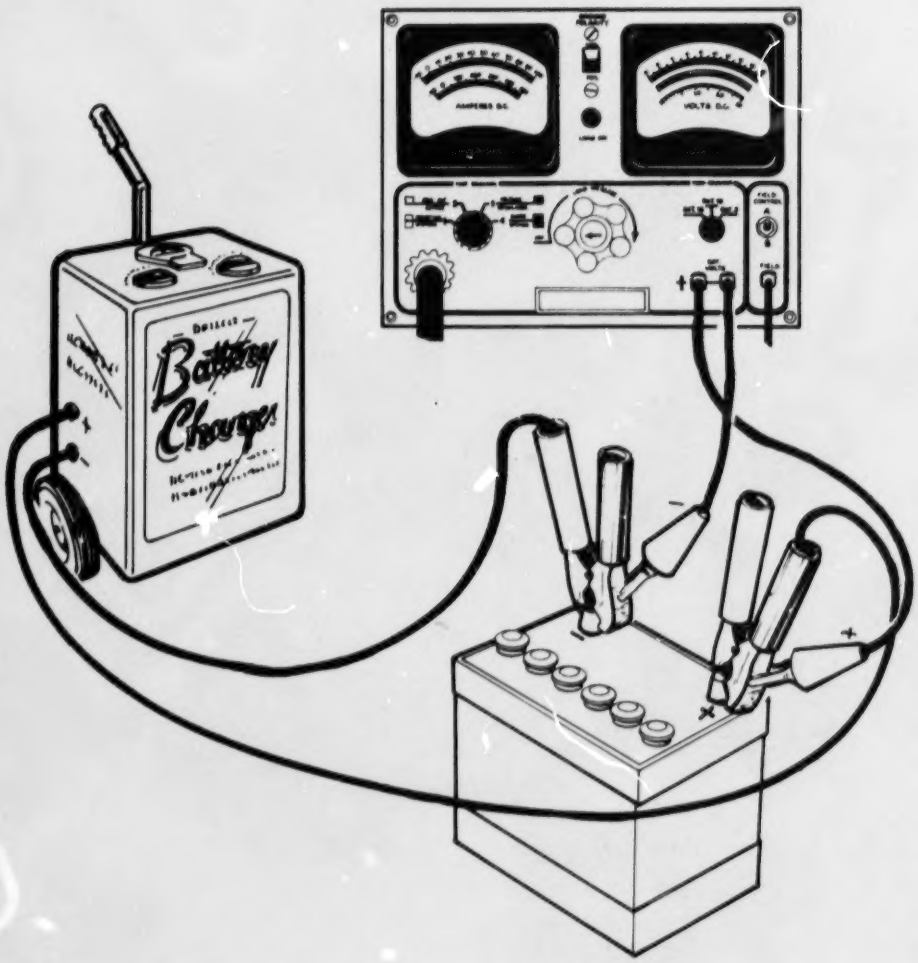
5.



6. 6.3 amperes
7. Decrease the charging rate to get the temperature below 125° F.
8. Stop the slow charge and replace the battery because the specific gravity has been the same for three hours and there would be no value in continued charging. When a battery won't accept a charge, it must be replaced.
9. Continue slow charging because the battery isn't yet fully charged. Also, the specific gravity hasn't stayed the same for three hours.
10. a. Stop the slow charge.
    b. 1.250 is a high-charge state.

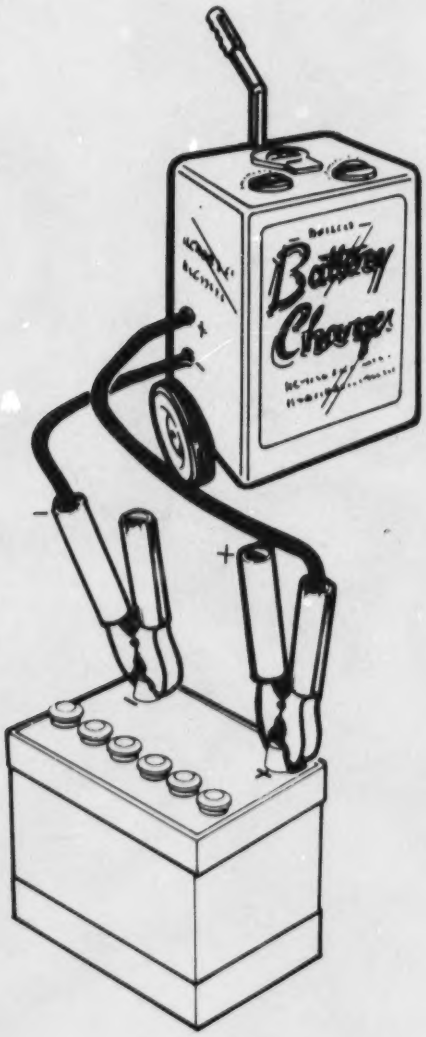
Now turn to page 60 in your Student Guide.

ANSWERS TO EXERCISE 6

1. b, c
2. a. or, open
   b. disconnect
   c. remove
   d. wood
3. a, b, c, d, f
4. 

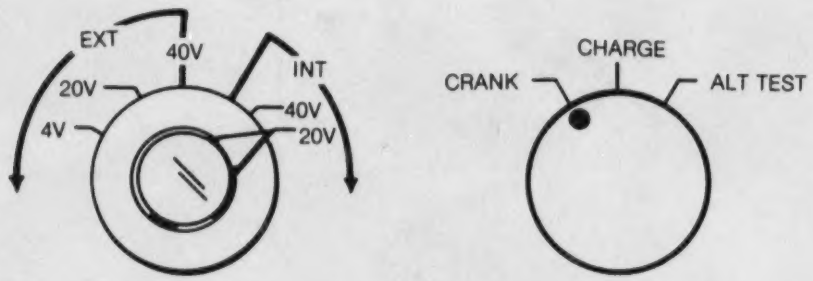
5. a
6. d
7. b
8. Check the voltage readings immediately and continue checking them. Stop the test if you find high voltage readings.
9. e

10. a
11. a
12. Stop the test and replace the battery.
13. You should replace the battery.
14. a. low
    b. boil, gas, or spray out
    c. low
15. b, c, d
16.



17. 35 amps
18. 0-15 minutes; yes
19. 30-45 minutes; yes

20. 0; no, the battery is fully charged
21. 0; no, slow charge only
22. b
23. by using a battery tester or voltmeter
24. Decrease the rate of charge and look for other danger signs.
25. Decrease the rate of charge again.
26. a. when the electrolyte temperature or voltage gets too high or when electrolyte sprays out
    b. at the end of the recommended time for the charge
27. b
28. Slow charge it.
29. a. load (amperes)
    b. load
    c. battery tester
    d. battery
30. a, b, c, d, e
31. These are the proper positions for the test selector knob:



32. a. 300 amperes
    b. load control, 300
    c. 15 seconds
    d. The battery would be damaged.
33. a. 235 amperes
    b. 15 seconds
34. 200 amps
35. 235 amps
36. 170 amps
37. during the 15 seconds that the load is applied
38. It is defective and should be replaced.
39. The battery is good.

40. a. Marginal. It may be good or bad.
    b. good
    c. defective
41. 9.6, 9.6
42. 9.6
43. Recharge the battery.
44. Check other parts of the cranking system.
45. before; because the test results will be more accurate

Now turn to page 69 in your Student Guide.

ANSWERS TO EXERCISE 7

1. a battery that needs electrolyte added to it before it can be used in a vehicle
2. 80 amperes
3. before installing it
4. a, b, c, d, e, f, i, j, k
5. b
6. b, c, d
7. a. break
   b. little
   c. split ring
   d. do not
8. Reinstall them and make sure the vent holes in the caps are open.
9. Rinse the battery with water and let it dry naturally.
10. a. empty
    b. rinse
    c. throw away
11. a. rinse
    b. slit
    c. throw away
12. a. close, upright
    b. inside
    c. cool, dry
13. a, c, e, f, g
14. a. Check the specific gravity.
    b. Slow charge the battery.

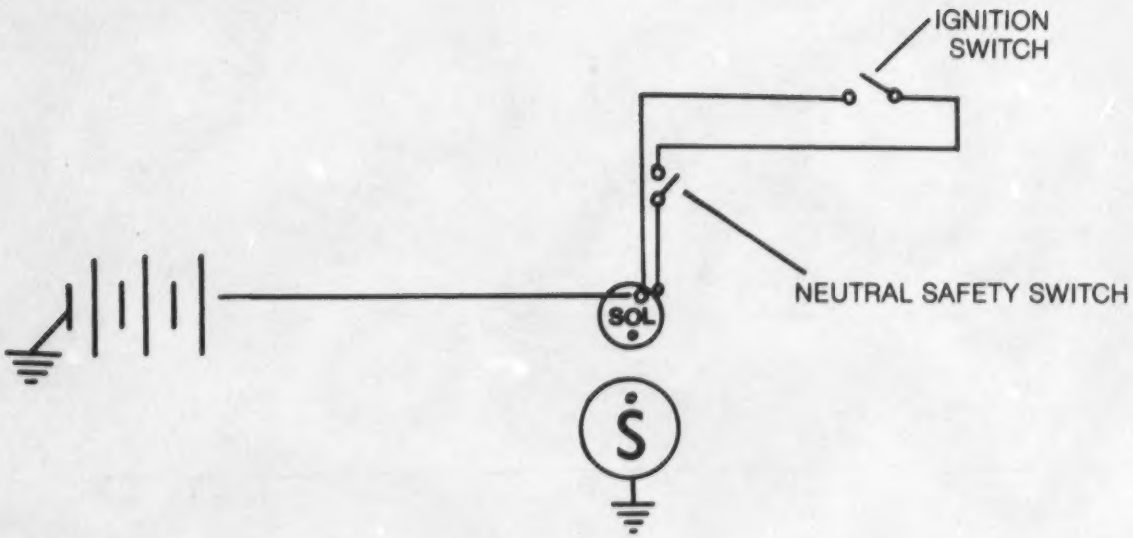
Now turn to page 73 in your Student Guide.

ANSWERS TO EXERCISE 8

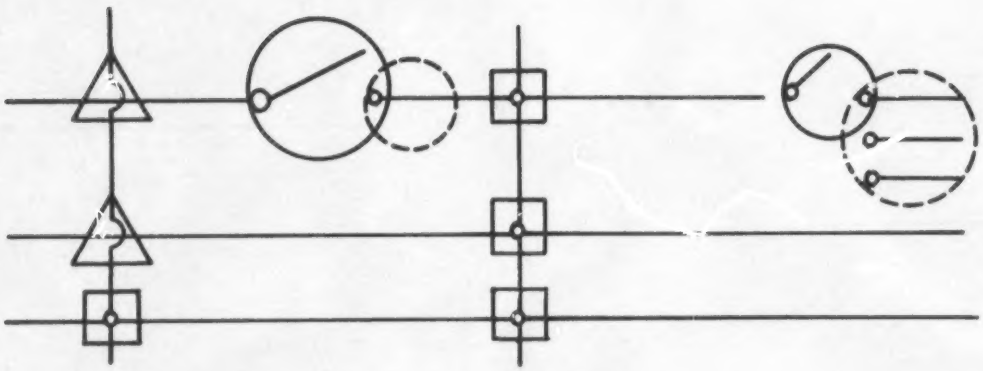
1. battery
2. flywheel
3. c

4. pinion, ring gear
5. All statements are true.
6. a
7. d
8. open
9. closed
10. open
11. technical service manual
12.

13.



14.



Now turn to page 84 in your Student Guide.

ANSWERS TO EXERCISE 9

1. Have someone else crank the engine for you.
2. Your fingers or loose clothing can get caught in the moving parts.
3. Use fender covers.
4. Metal rings can make contact with other electrical parts, and you can get burned.
5. a. battery and connections
   b. cranking motor drive
   c. cranking motor drive spring
   d. dragging of armature or commutator
   e. short in armature or commutator
   f. loose contacts from solenoid or starter relay to cranking motor
   g. burned or shorted-out wires
   h. worn ring gear teeth

Now turn to page 90 in your Student Guide.

ANSWERS TO EXERCISE 10

1. a. 2
   b. 3
   c. 1
2. by cranking the engine
4. a. Check the battery.
   b. Perform the continuity test.
   c. Perform the starter draw test.
   d. Perform the voltage drop test.
5. a. center cable, distributor cap
   b. positive lead, ignition coil
6. Wrap it with a cloth or tape.

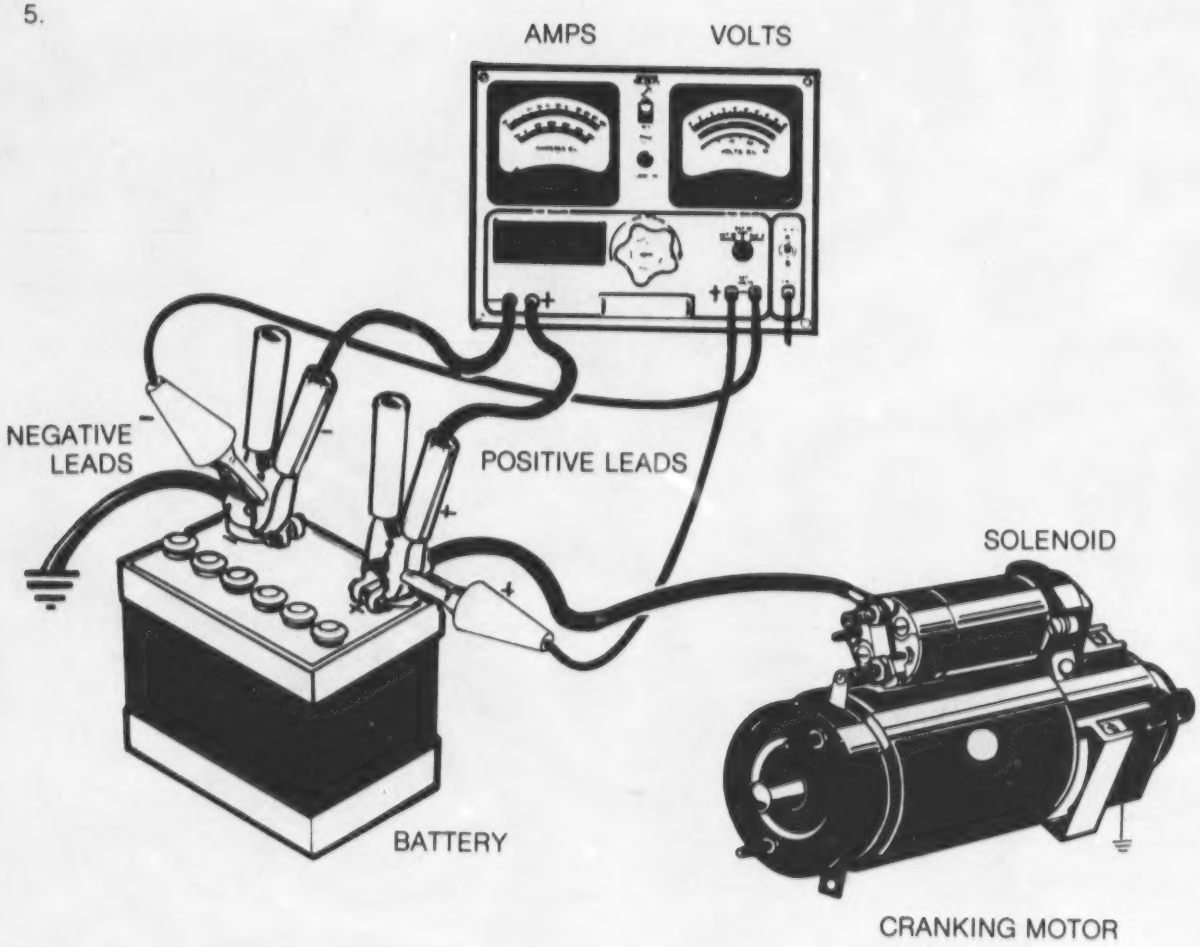
7. a. voltmeter
   b. electrical circuit tester (test lamp)
8. ground, electrical unit
9. ground, test point
10. c, b
11. c, a
12. d, a
13. e, a
14. f, a
15. g, a
16. h, a
17. i, j, k, l, m, test point, a
18. n, o
19. n, p
20. n, a
21. after checking the circuit between the junction block and the ignition switch
22. connections
23. Check the battery electrolyte and terminal posts.
24. neutral safety switch
25. a. ignition
    b. emergency brake
    c. park
    d. clutch, crank
    e. neutral

Now turn to page 111 in your Student Guide.

ANSWERS TO EXERCISE 11

1. a or b, c, e
2. c
3. b
4. All statements are true.

5.

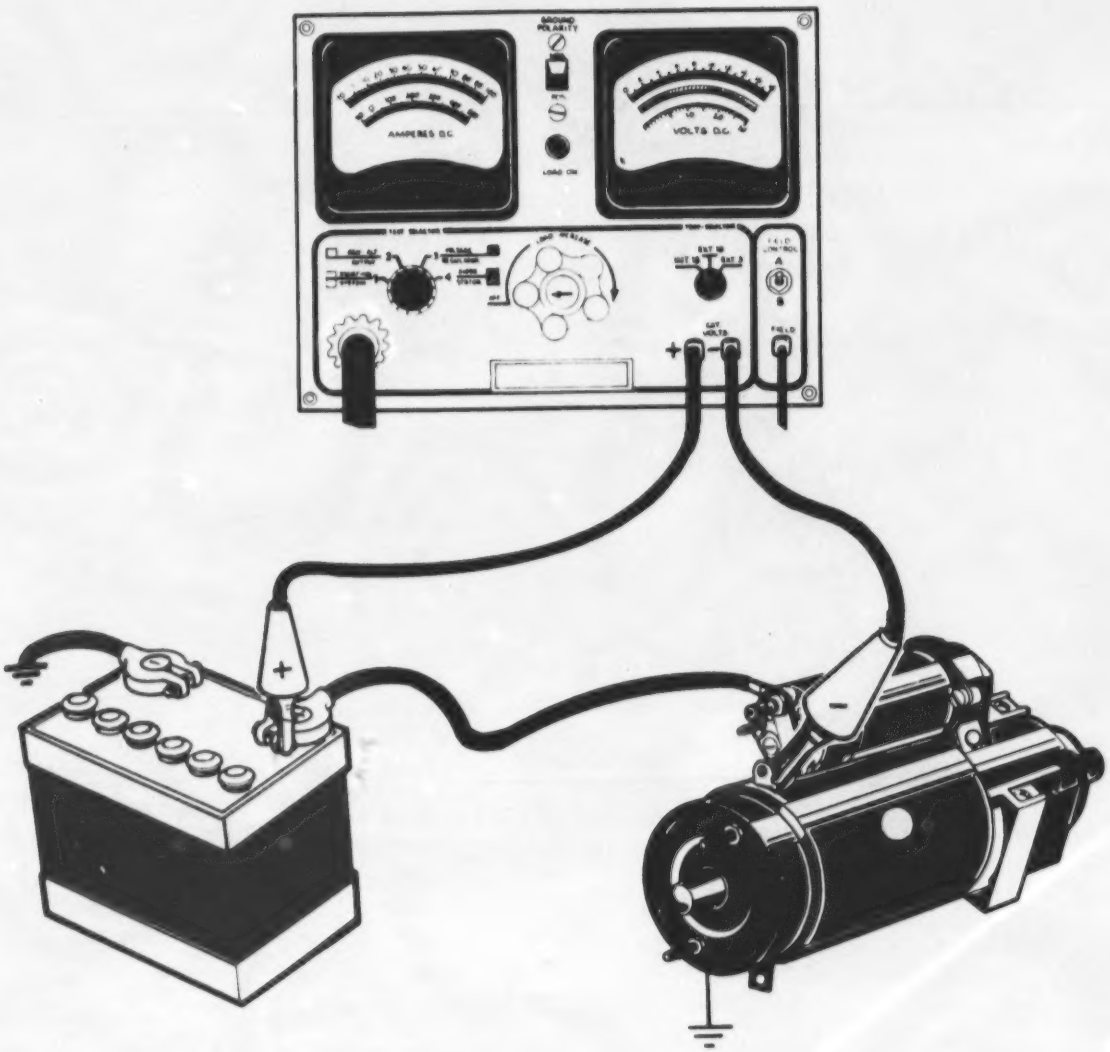


6. a. 3
   b. 7
   c. 5
   d. 1
   e. 6
   f. 2
   g. 4
7. b
8. b
9. a

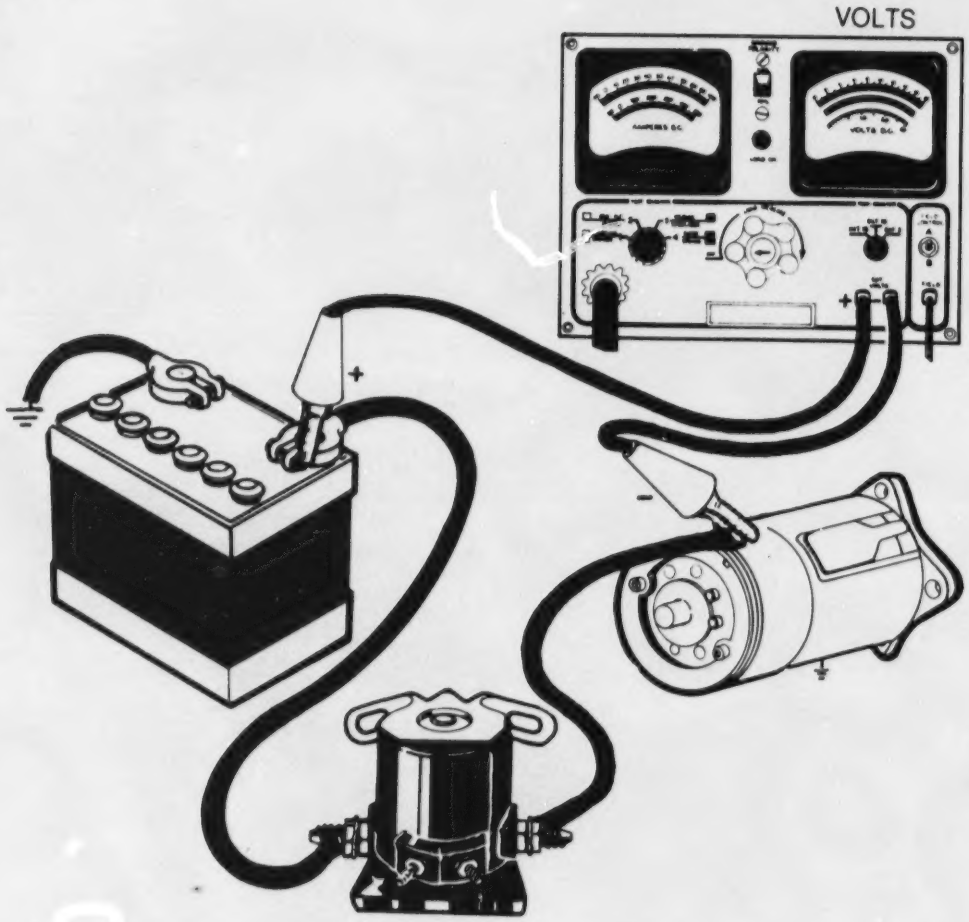
Now turn to page 115 in your Student Guide.

ANSWERS TO EXERCISE 12

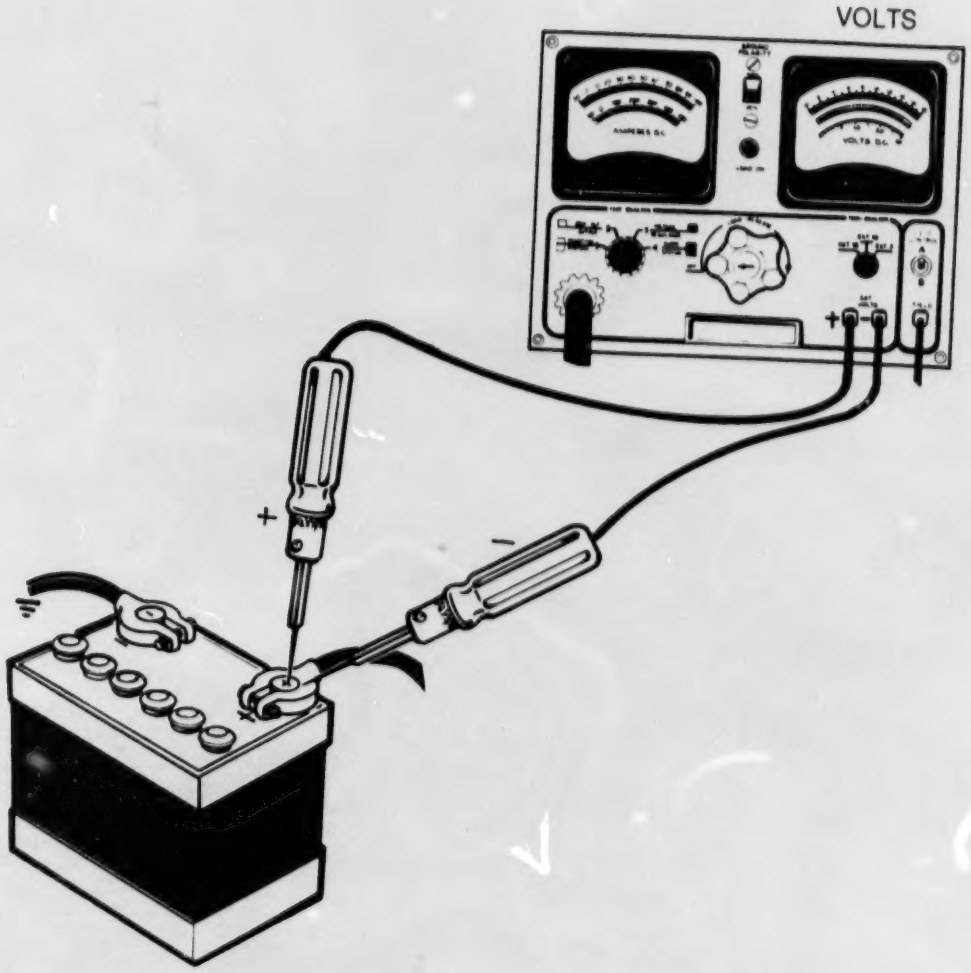
1. high
2. low
3. disable
4. emergency brake
5.



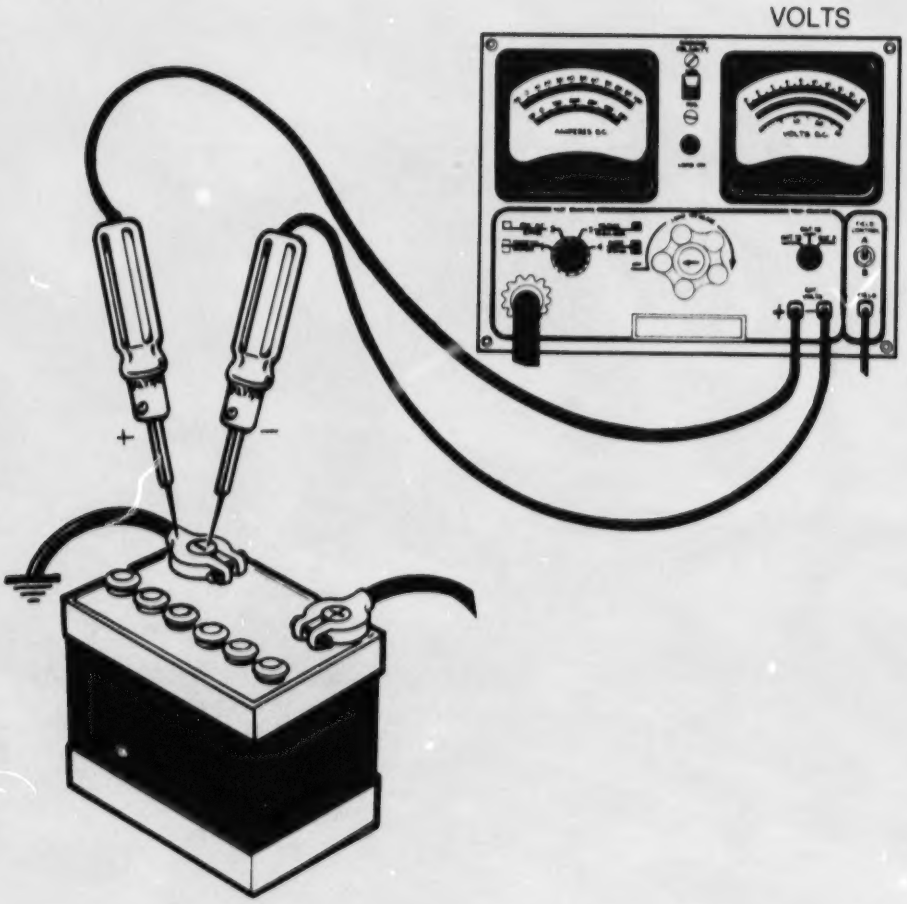
6. fig. 2-34



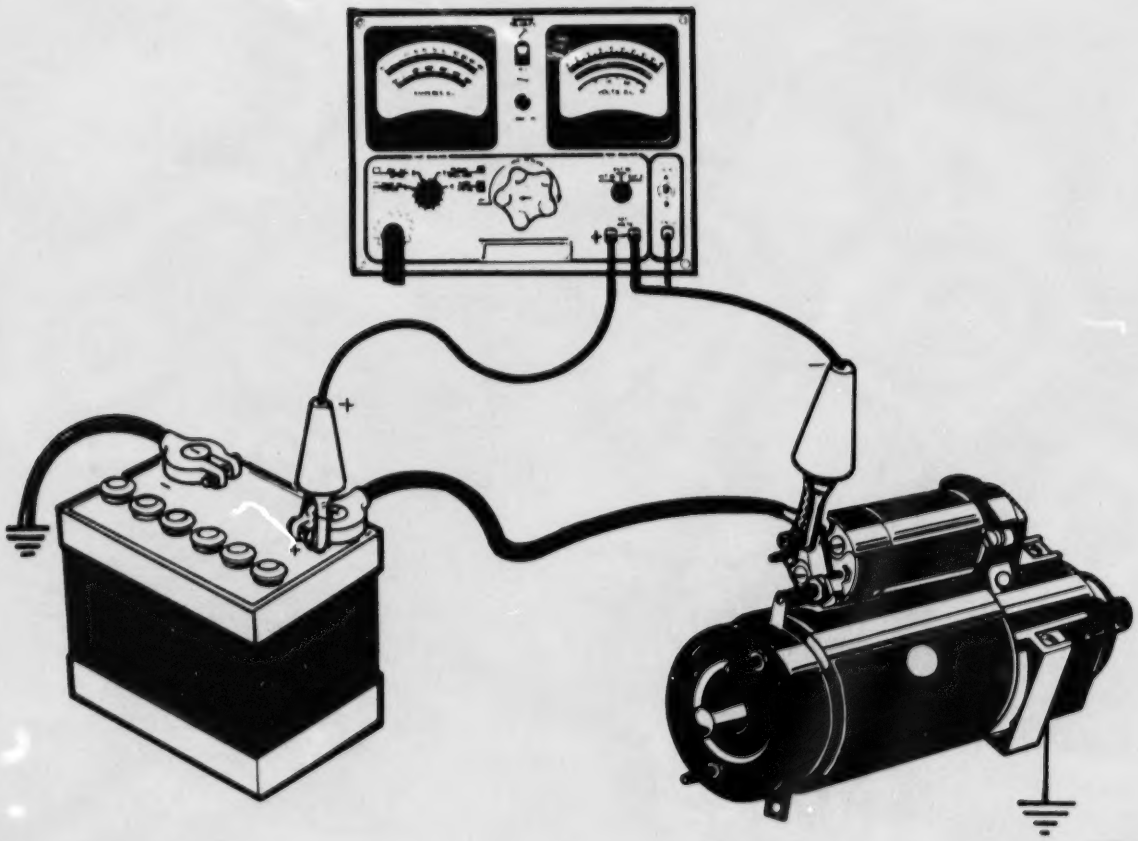
7. fig. 2-35



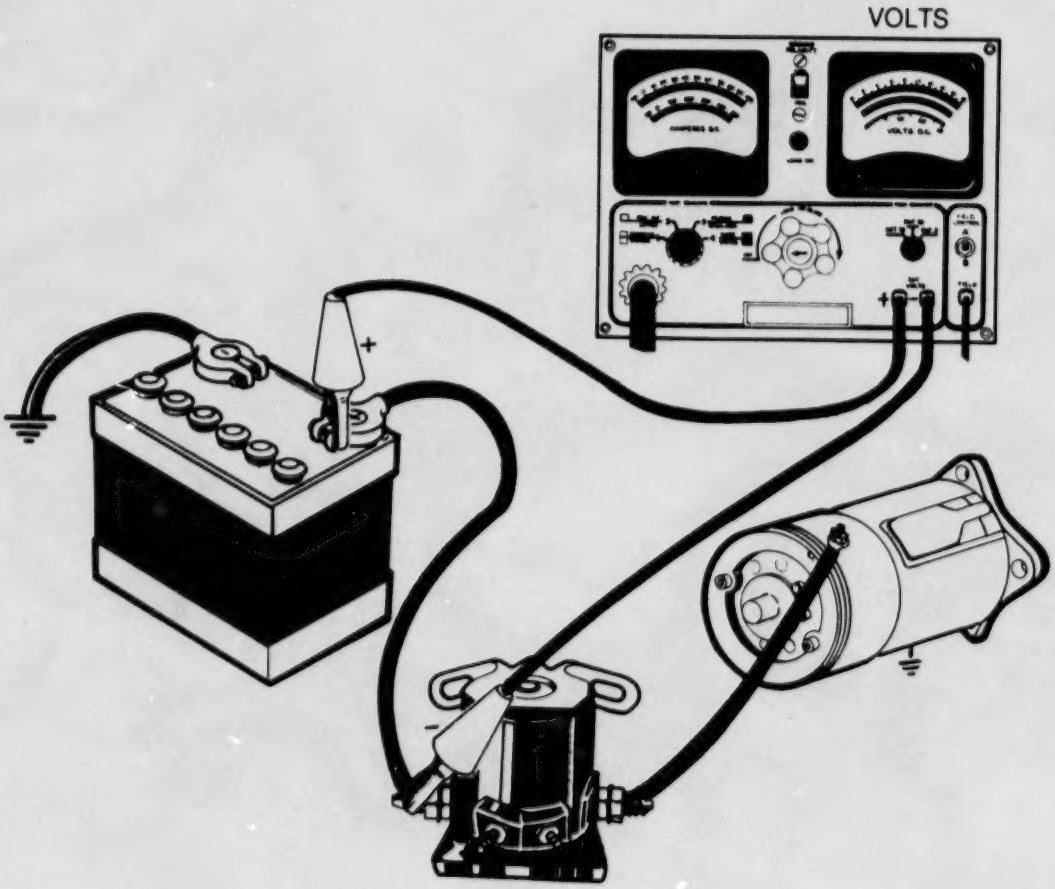
8. fig. 2-36



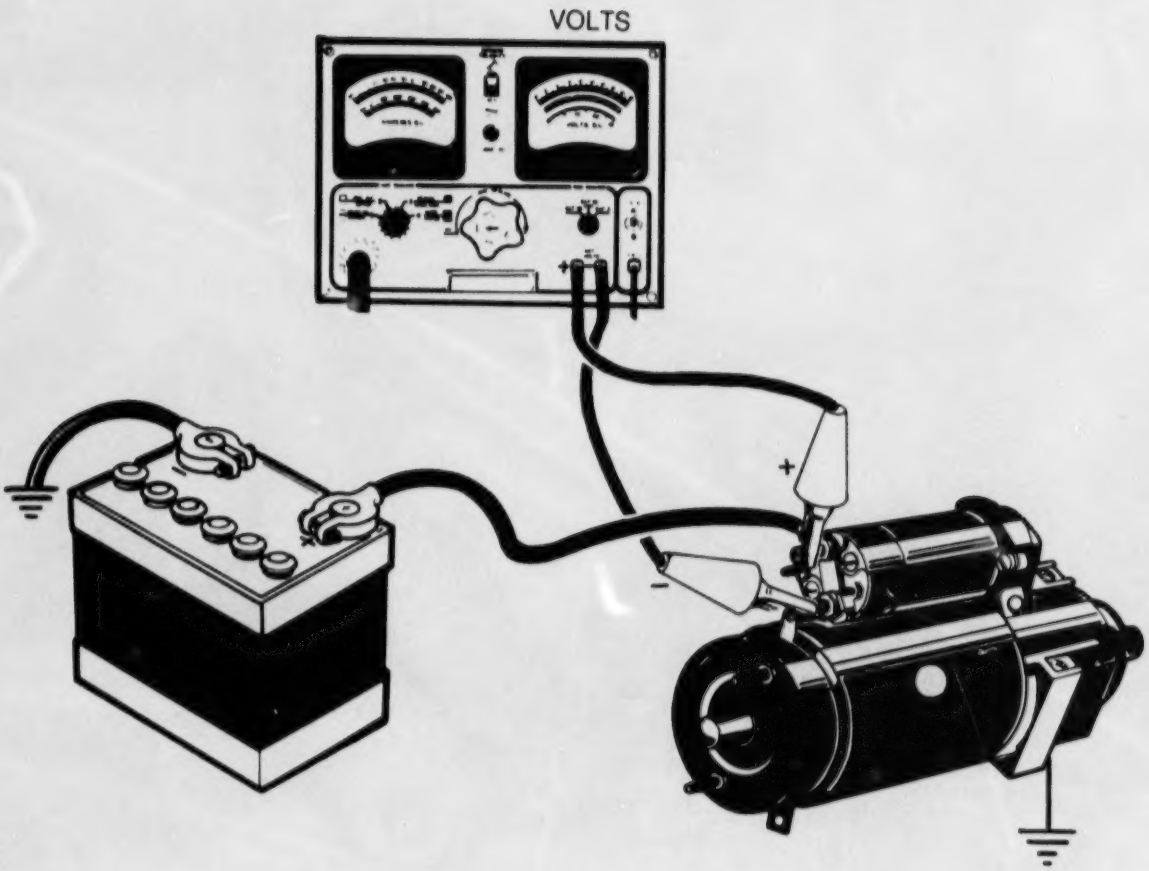
9. fig.2-37



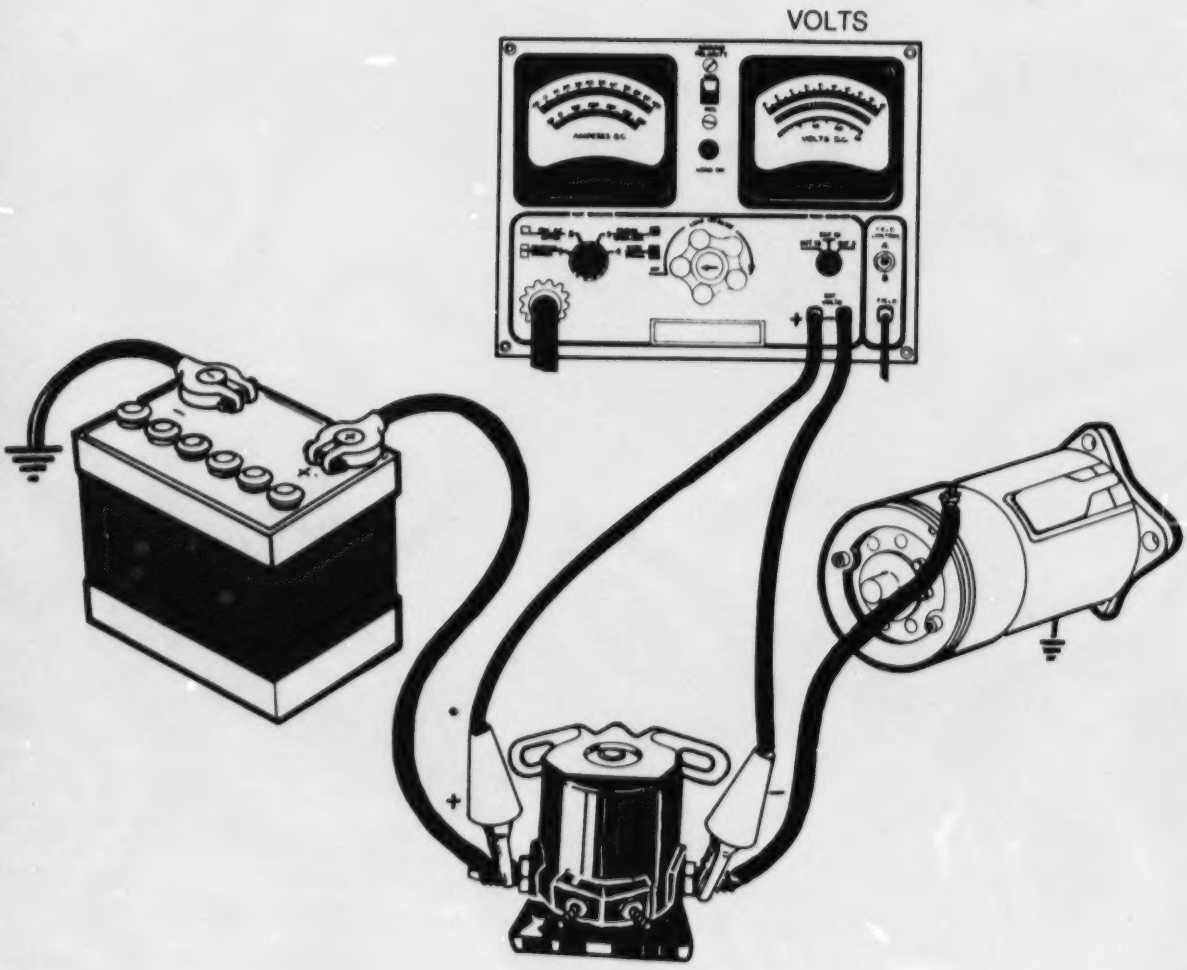
10. fig. 2-41



11. fig. 2-38



12. fig. 2-42



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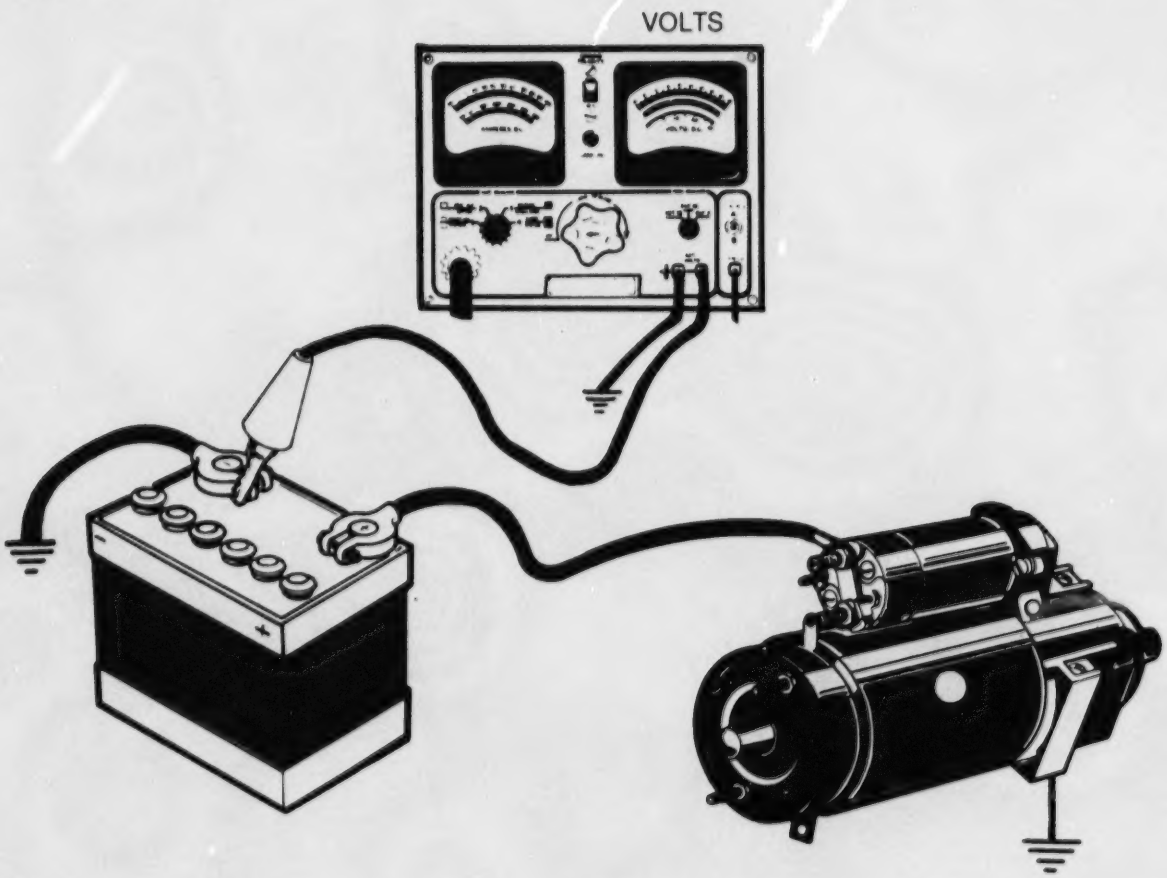
13. fig. 2-39



14. Check the connections at each test point. The voltage drop is too high.
15. Stop checking for voltage drop. This tests the whole system, and the voltage drop is not too high.
16. Check the connection at the positive terminal. The voltage drop is too high.
17. Check for voltage drop at the next place in the circuit. The voltage drop is not too high, but you still need to find where the voltage drop may be too high in the circuit.
18. Check for voltage drop at the next place in the circuit. The voltage drop is not too high, but you still need to check for voltage drop elsewhere in the circuit.
19. Check the connections at each test point. The voltage drop is too high.
20. Check for voltage drop at the next place in the circuit. The voltage drop is not too high, but you still need to check for voltage drop elsewhere in the circuit.
21. Check for voltage drop at the last place in the circuit.
22. Check the connections at each test point. The voltage drop is too high.

Now turn to page 128 in your Student Guide.

ANSWERS TO EXERCISE 13

1. a. weight, rated capacities
   b. frame
   c. slowly
   d. jack stand
   e. up, floor, trip
   f. rock
   g. resting securely, 1 foot
2. The jewelry can make contact with electrical connections and give you a severe burn.
3. They can get caught in equipment.
4. Eye protection will keep loose dirt, metal, and other matter from falling into your eyes.
5. All statements are true.
6. c
7. Put them back on the terminals.
8. a. F
   b. T

Now turn to page 139 in your Student Guide.

ANSWERS TO EXERCISE 14

1. c
2. All statements are true.

Now turn to page 141 in your Student Guide.

ANSWERS TO EXERCISE 15

1. a. F
   b. T
2. a. cranking motor
   b. contact nut, screw
   c. mounting screws
   d. one-fourth
   e. cranking motor, return spring
3. a. cranking motor, return spring
   b. contact nut, screw
   c. seal, cranking motor
   d. mounting screws
   e. reinstall
   f. cranking the engine

4. 1. a
   2. a
   3. b
   4. c
   5. c
   6. d
   7. d
   8. e

Now turn to page 150 in your Student Guide.